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REMEDIAL INVESTIGATION
SAMPLING AND ANALYSIS PLAN

Midway Landfill

Kent, Washington

DECEMBER 4, 1985

**State of Washington
Department of Ecology
Remedial Action Division
Office of
Hazardous Substances and Air Quality**

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1.0 INTRODUCTION

This sampling plan has been developed for the Midway Landfill, located in the City of Kent, Washington, as part of the remedial investigation and feasibility study being conducted for the site. The sampling program developed for the site will provide the data necessary to formulate and evaluate alternative remedial actions and to develop the conceptual design(s) of the preferred remedial action for final site remediation, consistent with State (including Chapter 70.105RCW), Federal (including CERCLA, RCRA, TSCA), and local policies and guidelines designed to protect human health and the environment.

1.1 SITE LOCATION AND DESCRIPTION

The Midway Landfill is a privately owned landfill that was operated by the City of Seattle Solid Waste Utility from 1966 to 1983. The site consists of approximately 60 acres, located at South 248th and Pacific Highway South, inside the City of Kent, and is approximately 16 miles south of Seattle. The site is bordered on the east by Interstate 5. The site was formerly the location of a gravel mining operation and a peat bog lake, Lake Mead. The regional setting and site boundaries are shown on Figure 1.

Although the facility was to be operated only as a non-putrescible landfill accepting demolition and transfer station wastes, it has been reported that unknown quantities of solvents, organic and inorganic chemicals, heavy metals, and contaminated dredge materials have been placed at Midway.

The presence of methane and other gases generated during the decomposition process of the landfill materials presents potential threats to human health and the environment at the site. Additionally, there is concern over the possible presence of organic vapors from solvents and other organic compounds allegedly disposed in the landfill.

The groundwater analysis performed on the site monitoring wells indicated the presence of heavy metals and organics contamination. The presence of methane gas in the landfill and migration of the gas off the property has also caused concern over safety issues for surrounding residences and businesses.

Currently, the Seattle Engineering Department is investigating options for closure of the site under State of Washington solid waste guidelines. As part of this effort, geotechnical and hydrological investigations were performed and alternatives for closure of the site have been developed. The Seattle Engineering Department has completed a series of field investigations at the landfill site since 1982, including a system of methane flares and standpipes throughout the facility, shallow and deep gas probe clusters for gas monitoring, and groundwater monitoring wells. Most recently, the City has directed the implementation of a gas control system which consists of a curtain of gas extraction wells around the perimeter of the site, a gas collection system of piping and headers, and temporary blowers and flares to burn the gas. The City is currently completing the system and will construct a single permanent blower and flare system to serve the gas collection system.

1.2 SCOPE OF FIELD ACTIVITIES

The field activities for the Remedial Investigation of Midway Landfill are described in this sampling plan. The scope of the field activities was developed based on an evaluation of existing information, identification of data gaps and the extent of data gaps, and the identification of the types and extent of data needed to formulate remedial action alternatives. Background information relating to the site and the results of previous sampling and monitoring efforts may be found in the "Forward Planning Document for Midway Landfill", dated March 7, 1985, prepared by Black & Veatch for the State of Washington, Department of Ecology.

The following sections present a summary of the remedial investigation objectives, a brief description of data currently available, and a description of the field activities designed to obtain the data needed to meet the remedial investigation objectives. Included is a summary of the types of samples to be obtained, the numbers and locations of samples, sampling methods, and laboratory analyses. The Quality Assurance Project Plan, which describes sample handling, analytical chemistry, sample chain-of-custody, and other QA/QC procedures, is provided as a separate document, as is the Site Health and Safety Plan.

2.0 REMEDIAL INVESTIGATION FIELD ACTIVITIES

The purpose of the field activities phase of the remedial investigation for Midway Landfill is to obtain sufficient data to identify the magnitude and the extent of contaminant and gas migration and to assess remedial action alternatives during the feasibility study. The collection and review of all data developed during the investigation will be done in a legally defensible manner, in accordance with CERCLA guidelines.

The investigation will consist of activities to be conducted in four major areas: geologic investigations; hydrologic investigations including groundwater, surface water, and leachate; an air quality investigation; and an investigation to identify receptors. In general, the technical objectives of the investigation include the following:

- o define subsurface stratigraphy and geohydrology at the Midway Landfill site
- o define the nature and extent of water, air, and soils contamination at the Midway Landfill site to support a subsequent remedial action feasibility study
- o define the nature and extent of landfill gas subsurface migration adjacent to the Midway Landfill site in support of current Initial Remedial Measures (IRM'S)
- o determine the efficiency of the gas control system implemented at the Midway Landfill site by the City of Seattle
- o expand on the existing technical data base to determine adequacy of the proposed City of Seattle final closure plan for Midway Landfill
- o further identify potential off-site contamination receptors adjacent to the Midway Landfill site

2.1 GEOLOGIC INVESTIGATION

2.1.1 Subsurface Stratigraphy

2.1.1.1 Objectives

Definition of the subsurface stratigraphy at the Midway Landfill is critical in understanding the occurrence and movement of landfill contamination (landfill gas and leachate) at the site. Representative geologic samples collected from boreholes completed in and around the landfill (during installation of gas probes, leachate wells, or groundwater monitoring wells) provide the basis for identifying stratigraphic units and delineating the extent of these units over the site and contiguous areas. Geologic logs of boreholes are used to construct geologic cross sections of the site that depict subsurface conditions and describe key stratigraphic units.

2.1.1.2 Evaluation of Existing Data.

The draft "Environmental Impact Statement for Closure-Midway Landfill", City of Seattle, 1985 includes cross sections through the landfill that utilize existing monitoring wells as control points. These cross sections delineate landfill materials and glacial strata beneath the fill area and adjacent properties, down to an elevation of about 225 feet above mean sea level. Stratigraphic identification and delineation of contacts between strata are estimated over much of the site, however, mainly due to the limited quality of geologic samples provided by the air rotary drilling technique that was utilized in installation of many of the monitoring wells and gas probes. The thickness and extent of the glacial units underlying the landfill and surrounding area need to be determined more accurately, especially the finer-grained strata (silts and clays) which appear to influence groundwater occurrence and movement. Subsurface conditions should also be defined beyond the boundaries of the landfill by utilizing geologic information from offsite monitoring wells, gas probe boreholes, and water supply wells.

2.1.1.3 Sample Collection and Analysis Rationale.

Additional subsurface information will be obtained from new monitoring wells, leachate wells, and landfill gas probes to be installed in and around the landfill. Cable tool and hollow stem auger drilling methods will be employed to obtain representative geologic samples at regular depth intervals using standard ASTM split spoon methods. These new geologic data will be interpreted in conjunction with existing test boring information to further define subsurface conditions in the vicinity of the site. Details regarding locations, depths, and installation methods for new landfill gas probes and monitoring wells are described in subsequent sections of this sampling plan.

2.1.2 Soils Investigation

2.1.2.1 Objectives

The objective of soils investigations at the Midway Landfill site is determination of any soils contamination which has occurred due to past disposal practices at the site and any new soils contamination which may be occurring due to migration of contaminants off-site.

2.1.2.2 Existing Data

Near surface soils comprise the upper six feet of the study area. Records of boreholes indicate that there is no site cap on the landfill site itself, and that the fill generally consists of a dark gray to black mixture of decomposed paper, plastic, steel, wood, and some soil used for fill material or daily cover. Boreholes in the perimeter of the landfill show near surface soils consisting of brownish gray fine to coarse sands. The characteristics of "terminal 5" sediments which were deposited at the site in recent years has been determined, and those materials do not appear to present a contaminant problem with respect to leaching of metals or other hazardous properties.

Those sediments are currently stored on the surface of the landfill on an approximately one acre site, and apparently will be graded and covered as a part of the overall closure plan for the site prepared by the City of Seattle. The closure plan for the site will include final grading of the site, filling of the remaining pond areas at the site which currently create an infiltration problem into the fill material, and a final soil cap of relatively impermeable uncontaminated soil to retard infiltration.

2.1.2.3 Sample Collection and Analysis Rationale

No further sampling or analysis of existing on-site soils or the "terminal 5" sediments will be completed as a part of the remedial investigation. Adequate data exists to define the quality of these geologic materials and the site closure plan will totally cover these materials with a cap of uncontaminated relatively impermeable soil. No future contamination or contaminant migration is likely due to the presence of the existing near surface soils.

Off-site soils have not been characterized to date with respect to contaminant migration from the Midway Landfill site. Soil contamination could occur locally due to leachate seeps originating from within the subsurface strata of the landfill material. Therefore, soils samples from approximately 15 seep areas around the perimeter of the landfill will be obtained to characterize any potential leachate-caused soils contamination. These samples will be obtained using a shallow soils coring device at the 0-2 foot depth in the immediate area of leachate seeps which are discovered during the remedial investigation. Several soil cores from the immediate area of the seep will be composited to prepare a single homogenous soil sample for laboratory analysis. Each sample will be extracted in the laboratory and analyzed for those parameters listed in Table 4C.

2.2 HYDROGEOLOGIC INVESTIGATION

2.2.1 Leachate Characterization

2.2.1.1 Objectives

Leachate samples are useful in landfill investigations to evaluate the chemical composition of the leachate as a source of groundwater contamination. Definition of key indicator parameters in leachate from a particular landfill can provide a means of tracking groundwater contamination away from the landfill. The distribution of leachate and leachate fluid levels are important factors in evaluating the potential for horizontal and vertical leachate migration.

2.2.1.2 Evaluation of Existing Data.

The draft "Environmental Impact Statement for Closure-Midway Landfill", (City of Seattle, 1985) presents fluid levels and chemical data from two wells completed in the landfill material. Fluid levels indicate that water is

collecting in a perched condition above the local water table. Chemical data from leachate analysis shows elevated concentrations of typical leachate parameters (total dissolved solids, ammonia nitrogen, and iron). Although these data are useful, additional leachate wells installed in other parts of the landfill are needed to define fluid levels and leachate quality across the site.

2.2.1.3 Sample Collection and Analysis Rationale.

A total of 3 additional leachate monitoring wells will be installed within the Midway Landfill at the approximate locations shown on Figure 3. The leachate wells will be installed by the hollow-stem auger method, using construction techniques and well design described in the groundwater monitoring section of this plan and in Figure 5. The anticipated depths and screened intervals of the leachate monitoring wells are shown in Table 1. Each borehole will be drilled to a depth of approximately 30 feet below the bottom of the fill. Geologic samples will be collected from the 30-foot zone at 5-foot intervals, and the 30-foot zone will be backfilled with bentonite slurry grout. Subsequently, well development and drawdown tests to determine landfill permeability will be performed. Leachate monitoring wells will be sampled using the same methods and analyzed for the same parameters described in the groundwater monitoring section of this sampling plan (see Table 3).

2.2.2 Groundwater Hydrology and Characterization

2.2.2.1 Objectives

The major objectives of the groundwater portion of the hydrogeologic investigation are to determine the extent and migration rate of groundwater contamination at the Midway Landfill. This determination requires an understanding of the occurrence, movement, and quality of groundwater in the earth materials beneath and adjacent to the landfill. Properly constructed and located monitoring wells provide geologic, water level, and water quality data. These data allow determination of horizontal groundwater flow directions, vertical groundwater gradients, groundwater migration rates, and groundwater quality, and enable the impacts of the landfill on the groundwater system to be evaluated.

2.2.2.2 Evaluation of Existing Data.

The existing monitoring well network on and adjacent to the landfill is shown in Figure 2. As noted in the Geologic Investigation section of this sampling plan, the existing data do not allow sufficient delineation of geologic units that may influence groundwater occurrence and movement in the vicinity of the landfill (sand/gravel versus silt/clay). In addition, the existing monitoring well network does not allow adequate determination of groundwater flow directions in the water table aquifer, vertical groundwater gradients from the water table to deeper hydrogeologic units, or the extent of groundwater contamination from leachate generated by landfill. Although records of water wells in the area have been utilized to compile a generalized regional groundwater flow map, a detailed well inventory in the immediate vicinity of

the landfill has not been compiled. A water well inventory can provide useful offsite geologic information, and is also necessary to determine the potential impacts of ground water contamination on local water supply systems.

2.2.2.3 Sample Collection and Analysis Rationale.

A. Water Well Inventory

An inventory of water wells within 1 mile of the landfill boundary will be compiled. The initial inventory will consist of tabulating water well records on file at Ecology. Local municipalities and utilities will be contacted to determine the buildings within 1 mile of the landfill that are served by a public water supply system.

Private wells no longer used for water supply may be accessible for water level and or water quality measurements. If necessary, contacts with individual land owners will be made to confirm locations of private wells. Such an effort would be coordinated with the public relations officer for the project.

Locations of public supply, industrial, domestic, and other water wells will be plotted on a map, and the records of these wells will be compiled. The service areas of water utilities will also be delineated on this map. The map and associated well logs will be utilized to select offsite wells for possible water level measurements and sampling, and to assess the susceptibility of water supply wells to contamination by groundwater migrating offsite from the landfill.

B. Monitoring Well Installation.

A total of 16 new monitoring wells will be installed in the vicinity of the Midway Landfill, at approximate locations shown on Figure 3. A two-phased approach will be used to drill and install the wells, with wells W1-W8, W11, and W15 (along with the three leachate wells) included in the first phase. Subsequently, wells W9, W10, and W12-W14 will be drilled and installed. The two-phased approach will allow the wells in those areas deemed most critical to be installed on a fast-track basis. Some of these new wells will screen the uppermost water table, while selected wells will be drilled below the water table to determine geology and water levels with depth. The anticipated depths and screened intervals of new monitoring wells are given in Table 1. In order to determine whether significant differences exist in the water quality between the upper water table and water table beneath the confining layer, dual completion wells will be placed at locations W1-W3, W5, W11, W13, and W15.

Dual completion wells will be completed in a single boring, and one or two gas probes will be installed in selected monitor well boreholes. A schematic drawing of the proposed installation technique for dual completion wells and probes is shown in Figure 4.

Geologic samples will be collected during drilling of the boreholes. The drilling techniques to be used include the hollow stem auger technique and the cable tool method. Although the hollow stem auger drilling technique provides excellent geologic samples, the method is generally limited to depths of about 100 feet. The method will not be applicable to all monitoring well completions

because the water table appears at depths of over 100 feet in portions of the site area. An alternate drilling technique that provides sufficient geologic sampling control is the cable tool method, which will be utilized to install monitoring wells at depths beyond the capability of the hollow stem auger.

During drilling of boreholes, geologic samples will be collected at 5 foot intervals by driving a core sampler ahead of the borehole into undisturbed earth materials. The core sampler will be cleaned between uses with a detergent solution, followed by tap water and distilled water rinses. The depth of monitoring well completion will be selected based on the geologic characteristics and relative degree of saturation of formations penetrated. Screens in water table monitoring wells will be placed such that the tops are above the water table to allow for fluctuations. Upon reaching the appropriate depth, a 2-inch diameter PVC well screen and riser pipe will be installed through the auger (hollow stem) or casing (cable tool).

The annulus around each well screen will be filled with an appropriately sized sand pack, followed by a bentonite pellet seal. A bentonite slurry grout seal will then be placed around the PVC casing up to land surface, or to the elevation of the next well or probe screen for dual completion wells. Each seal will be allowed sufficient time to set prior to continuing with additional borehole operations. The augers or casing will be pulled during the backfill process, ensuring that the sand and gravel pack and seal are securely installed.

The wells will be secured at land surface by an appropriate diameter steel protector pipe or a steel flush-mount valve box or monument, depending on the location of the well. A locking cap will be installed on each valve box or monument to provide security for well caps. A permanent water level measuring point will be inscribed on each PVC well casing, and this measuring point will be leveled by a licensed surveyor to the nearest 0.01 foot mean sea level datum.

Augers and other down-hole components of the drilling rig will be steam cleaned prior to drilling at the site, between boreholes, and prior to leaving the site. Monitoring well casings and screens will be steam cleaned prior to installation. Cuttings and fluids from the drilling operation will be stockpiled on the landfill property for appropriate disposal.

C. Hydraulic Conductivity Determinations

Selected core samples of sand and gravel strata will be submitted to a soils laboratory for grain size analysis. Selected fine grained strata (silt, clay) encountered in boreholes will be sampled with a Shelby tube and tested for vertical hydraulic conductivity. Slug tests (rising and falling head) will be performed on all new monitoring wells to determine hydraulic conductivity of the water bearing formations penetrated.

D. Monitoring Well Sampling

A dedicated bladder type displacement pump will be installed in each new monitoring well, with access for manual measurement of water levels and attachment of equipment to power the pump. All existing and new monitoring

wells will be sampled three times each. Existing monitoring wells will be sampled using in-place pumps or appropriate bailers or pumping devices carried into the field.

Prior to sampling, a complete round of water level measurements will be collected and the volume of water standing in each casing will be calculated. An appropriate number of casing volumes will be evacuated prior to collecting the sample from the pump discharge.

Samples for metals will be passed through a 0.45 micron filter prior to preservation with acid. Other samples will be placed in appropriate bottles and preserved according to the applicable analytical technique. All samples will be accompanied by a chain of custody form. Field measurements and well evacuation procedures will be recorded and included in the sampling record.

E. Water Sample Analysis

The ground water samples will be analyzed for the parameters listed in Table 3. These parameters are based on constituents typically found in landfill leachate, and results of chemical analysis for samples from existing monitoring wells at the Midway Landfill (City of Seattle, 1985). This list of parameters was selected to allow characterization of background water quality and delineation of contamination by landfill leachate. Field parameters will be measured at the well head as soon as the sample has been collected from the pump discharge.

A minimum of three sampling events will be completed. In order to define changes in water quality due to climatic fluctuations, one of the sampling events will be completed following a wet weather period, and the other two after dry periods. An appropriate antecedent condition will precede each sampling event to assure validity of data. Each round of samples during each climatic period will consist of the entire range of parameters shown in Table 3. Upon receipt of the data from the analyses, an attempt will be made to correlate the degree of contamination present, as indicated by the presence of anthropomorphic organic compounds, with indicator parameters. If such a correlation can be made, subsequent rounds of sampling not included in this scope of work may proceed with analysis of those indicator parameters selected. Likely candidates for such parameters are indicated by the presence of an asterisk in Table 3.

2.2.3 Surface Water Quality Investigation

The objectives of the surface water quality investigation at Midway Landfill are listed below:

- o evaluate the effect of infiltration upon leachate production
- o measure the quantity and quality of stormwater entering the landfill from the I-5 drainage area
- o determine what effect precipitation induces upon monitoring well levels and evaluate the effect on well levels from the on-site North and Middle ponds

- o identify and characterize surface seeps in the area adjacent to the landfill

2.2.3.1 Existing Data

A limited amount of data is available to quantify the amount of inflow resulting from the I-5 drainage system. Water level plots produced from monitoring wells located on-site do not indicate a clear trend with relation to influent stormwater. The configuration of the drainage piping network within the landfill has not been clearly defined. Water quality measurements are available for the water that is trucked out of the landfill from the North Pond, but water level measurements have not been recorded for the pond.

At present two subsurface zones of saturation have been identified. One is above the water table and is a more or less isolated body of water. The other water table is much deeper and occurs within the Advance Outwash. However, both zones of saturation are believed to be recharged by precipitation falling in or around the landfill, from ponded surface water around the perimeter of the landfill, and from surface water directed into the landfill from east of I-5.

The quantity of leachate produced is affected to some extent by decomposition reactions, but is largely governed by the amount of external water entering the landfill. In order to estimate the quantity of leachate that is being generated at the landfill site, a number of "water balance" components are needed. These components not only deal with the infiltration of surface water into the landfill, but also with evapotranspiration, precipitation, surface runoff, flow of groundwater under the landfill (underflow), and the storm water drainage from the surface water directed into the landfill from east of I-5.

As previously reported ("Forward Planning Document, Midway Landfill", Black & Veatch, 1985), the landfill does not yield surface water out of its boundaries. The three ponds located on the property receive on and off-site drainage, as well as seeps from the fill material.

If average annual precipitation in the area is 37 inches ("Evaluation of Hydrology and Water Quality near the Tacoma Landfill", USGS, 1985), and the evapotranspiration for the same period is 10 inches, for a landfill with an area of about 60 acres (0.09 square miles), an average of 120,000 gallons per day of precipitation minus evapotranspiration must either go to runoff or infiltration. The distribution of such 120,000 gallons per day could be estimated to evaluate the amount of rainwater that seeps into the landfill.

A reasonable estimation of runoff can be made ("Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities", US EPA, 1980) for a sandy loam surface with no vegetation and an uncompacted rolling site condition such as Midway. If a 30 percent surface runoff is assumed for a 2.5 cm rainfall on a 4 percent slope such as at the Midway Landfill, an average of 84,000 gallons per day would be the amount of infiltration roughly calculated.

The volume of water absorbed by solid waste is termed its field capacity [generally 25.4 milliliters (1 inch) of water for each 0.3 meters of solid waste] and leachate will not be generated in any significant volume until

almost all of the solid waste has reached field capacity ("Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities", US EPA, 1980). For a typical case, based on the above water balance assumptions, a landfill with an average depth of 80 feet would saturate in a period of 4.5 years. However, channelling may occur, resulting in some leachate generation prior to reaching field capacity. Such could be the case at Midway because of the inflow of drainage water from east of I-5.

2.2.3.2 Sample Collection and Analysis Rationale.

The sampling program for assessing surface water will include the use of flow measurements and physical/chemical analysis. To quantify the amount of storm water entering the site, flow meters will be placed at the culvert that enters the landfill at the northeastern corner, and at the manhole located east of the site, as indicated on Figure 7. The flow meters to be used will be level sensor meters (ISCO type) that will be triggered during storm events. It is expected that at a minimum, two storm events will be monitored. To assess whether influent stormwater induces changes in water quality, a limited analysis will be done on the composite storm-water samples. The parameters for the analyses are listed in Table 4. Information will be gathered at the meteorological stations (addressed in a later Air Quality Monitoring section) concerning the duration of the storm events and the amount of rainfall and evaporation.

To evaluate the amount of runoff entering the Middle and Northponds, staff gauges will be placed in each pond with levels marked in 0.01 footgradations. Daily readings of the gauges will be taken throughout the duration of field activities. A survey of the ponds will be completed to determine their volume and capacity. Samples will be collected and analyzed from each pond in accordance with the parameters summarized in Table 4A.

A survey will be made to determine where leachate seeps are located around the landfill, and at what times seepage is present. Each seep will be sampled at least once for those compounds listed in Table 4B. It is expected that approximately 20-25 liquid samples will be analyzed. Approximately 15 soil samples will be collected at selected seeps and analyzed for those parameters shown in Table 4C.

2.3 LANDFILL GAS/AIR QUALITY INVESTIGATIONS

Gases produced by the landfill require further characterization. Subsurface migration of methane has produced measured concentrations above the lower explosive limit in offsite residential and commercial buildings and in a high percentage of the offsite gas probes installed by the City of Seattle. Emissions of methane, sulfides and organic compounds to ambient air may produce concentrations of some substances exceeding health and safety guidelines. Both gas transport pathways, subsurface and ambient air, require assessment during the undisturbed state as well as during remedial action phases. These pathways will be addressed separately in this section.

The City of Seattle is currently implementing a gas control plan for Midway Landfill. The plan consists of installing a curtain of positive pressure gas

extraction wells around the perimeter of the landfill, extracting gas from the landfill and surrounding migration area using blowers and burning the gas in a flare system on the site. The system is currently partially operational.

2.3.1 Subsurface Gas Migration

2.3.1.1 Objectives

The objectives of the sampling activities associated with subsurface gas migration are to:

- o expand the current landfill gas monitoring and sampling data base
- o determine efficiency of the Midway Landfill gas control plan
- o better estimate the present extent of landfill gas migration
- o identify migration conduits and landfill gas accumulation points
- o determine predominant transport mechanisms
- o determine compositional changes in gas as it migrates away from the landfill

2.3.1.2 Existing Data

The four main sources of existing data related to subsurface gas migration are: (1) periodic methane concentration measurements made by the Seattle Engineering Department at gas probes in the landfill and at several nearby areas, (2) weekly to biweekly methane concentration measurements made by City of Seattle consultants and local and state agencies at permanent gas probes outside the landfill, (3) gas composition measurements made by University of Washington personnel at three flares in the landfill (July, 1985), and (4) well logs and construction diagrams prepared by Golder & Associates for the permanent gas probes outside the landfill (June, 1982 and July, 1985).

These data, especially the methane concentrations at the permanent probes, indicate that explosive conditions may exist in a relatively large area surrounding the landfill. Measurements of combustible gas levels both on- and offsite have shown levels greater than 60 percent by volume. Although the data that are presently available do not allow the full extent of landfill gas migration to be estimated with any level of confidence, there are indications that the methane concentration may exceed the lower explosive limit (4 percent methane by volume) over distances greater than 1,000 feet from the landfill boundaries. Furthermore, air quality analyses performed on samples from landfill flares suggest that the gas that is migrating away from the landfill may contain hydrogen sulfide, benzene, and carbon tetrachloride at the source in amounts exceeding the 1985 EPA threshold limit value (University of Washington, July, 1985).

Several gaps can be identified in the existing data. These gaps can be categorized into four general groups:

- o data needed to determine total and partial pressure gradients in lines perpendicular to the landfill
- o data pertaining to the composition of the landfill gas as it migrates from the site
- o data describing manmade and natural migration conduits and accumulation points
- o data defining geologic stratigraphy and material properties

2.3.1.3 Sample Collection and Analysis Rationale

A. Gas Probe Installation

Currently, approximately 65 shallow (10 foot) gas probes are being installed around the landfill to assess gas migration in the most important subsurface zone. Gas may be migrating through the soil and through various subsurface conduits such as utility pipes and vaults, emerging at breaks in the soil surface such as basement excavations and at sewer manholes and other utility surface projections, and through natural vents or cracks in the soil surface. The system of shallow probes is designed to detect gas in this upper subsurface zone in a 500-1,000 foot perimeter around the landfill and in a systematic manner.

In addition to existing gas probe installations, six additional clustered gas probes will be installed at locations of existing shallow probes as shown on Figure 3. Each probe cluster will consist of two probes screened at depths of approximately 10 to 50 and 60 to 100 feet, respectively.

A typical construction diagram for the probe clusters is presented in Figure 6. Borings for the probes will be drilled with a hollow stem auger or by the cable tool method with split spoon sampling at 5-foot depth intervals. Grain size analysis will be performed on selected samples. Each borehole will have a maximum depth of 100 feet and will be completed above the groundwater table. It is not expected that significant gas migration is occurring in the saturated zone below the uppermost water table.

Additional gas probes will be installed at selected monitoring well locations as shown in Table 2 and in Figure 3. The exact number and locations for these probes will depend upon the stratigraphy that is observed at the time of installation. Monitoring well probes will consist of 3/4-inch Schedule 80 PVC casing with 0.02 inch slotted screen. Length of screen will depend on the stratigraphy encountered at each borehole. Deeper probes will generally have longer screen intervals.

Each sampling interval will be surrounded with sand and gravel packs that will be sealed above and below with at least two feet of bentonite. The bentonite seal will be formed from bentonite pellets or from a finer granulated bentonite material to ensure proper placement around the casings and a secure seal to prevent interzonal migration within the borehole.

B. Gas Probe Monitoring and Sampling

Landfill gas monitoring is currently being conducted for shallow and deep probes and for selected surface locations in residential and commercial buildings under the direction of the City of Seattle Engineering Department. Monitoring for these locations is limited primarily to combustible gas concentration with the objectives of identifying areas where explosive gas concentrations may exist and determining extent of gas migration. The location and construction details of existing probes are presented in the "Draft Environmental Impact Statement for Midway Sanitary Landfill Closure," (Seattle Engineering Dept, August, 1985) and selected probe locations are also indicated as "existing" probes on Figure 3. Landfill gas monitoring and sampling to be conducted in accordance with this sampling plan is intended to enhance the existing data base and provide additional data to achieve the objectives of the gas monitoring and sampling task of the remedial investigation.

Gas monitoring will be conducted using the following procedures:

- 1) The new system of shallow gas probes and deep probe clusters and selected existing City of Seattle probes will be monitored in a time- correlated sequence. Exact sequence will be determined by the field monitoring team.
- 2) Three discrete rounds of monitoring will be conducted on selected probes including approximately 50 percent of shallow probes and all operable deep probe clusters.
- 3) Measurements at gas probes will include total pressure, combustible gas concentration, hydrogen sulfide concentration, carbon dioxide concentration, and organic vapor analysis in a survey mode (total organics).
- 4) Organic vapor analysis will be conducted in the chromatographic mode at approximately 25 percent of monitored probe locations in order to semi-quantitatively "fingerprint" the gas components.
- 5) Gas samples will be obtained at approximately five (5) of the probe locations with highest organics concentrations or unique chromatographic pattern, during each round of monitoring. Samples will be obtained using an appropriate pumping device on Tenax resin or activated carbon collector tubes. Samples will be desorbed in the laboratory and analyzed for ten characteristic hydrocarbons based on field chromatographic results. Representative laboratory analyses expected to be performed, based on existing landfill flare gas samples, are summarized in Table 5.
- 6) Total pressure measurements will be obtained with a portable manometer. These measurements will be used to determine if the methane transport mechanism is dominated by total pressures (advective transport), partial pressures (diffusional transport), or a combination of both.
- 7) Carbon dioxide measurements will be obtained with a portable gas detector or detector tubes. The presence of carbon dioxide will help verify that the source of the methane is the landfill.
- 8) Organic vapor analysis will be completed using a portable organic vapor detector which can be set to measure total organics in a survey mode, or can be

attached to a data recorder and set in chromatographic mode to obtain a relative chromatograph, calibrated to a known compound, which will yield a chromatographic "fingerprint" or trace of those organics which elute through the chromatographic column during a preset measurement period. Comparison of chromatographs produced by this method will indicate the relative distribution of organic vapors at various probe locations and will yield quantitative data for those organics which produce a complete trace relative to a standard instrument calibration. Chromatographic data obtained by this technique will be verified by comparison with laboratory GC data from duplicate gas samples.

Data obtained by the above gas monitoring methods and procedures will be analyzed in accordance with task objectives to determine the extent of gas migration, gas characteristics, and gas control plan effectiveness.

C. Identification of Gas Migration Conduits

An inventory will be conducted to identify possible migration conduits and accumulation locations for the landfill gas. The inventory will include sewer lines, drainage pipes, buried utility lines, basements, crawl spaces, and culverts. The primary source of information for this inventory will be existing maps and records. A significant amount of buried utility information is being generated during installation of shallow gas probes as each probe site is marked by the local utility locator service. The continuation of this data gathering will concentrate on areas already known to be areas of gas accumulation.

Spot checks of combustible gas concentrations at points identified in the inventory as probable gas accumulation locations will be performed by the remedial investigation field team using a portable gas detector. If any of these additional measurements indicate the presence of combustible gases, recommendations will be made for a more extensive monitoring program to be implemented.

2.4.2 Ambient Air Quality

2.4.2.1 Objectives

An ambient air quality investigation will be performed as part of the remedial activities to be conducted at Midway Landfill. The objectives of the investigation are summarized as follows:

- o define the extent of landfill gas migration in ambient air on and around the landfill site
- o characterize the composition of the gases emitted by the landfill, with particular attention devoted to identifying and quantifying organic components and compounds containing sulfur
- o estimate exposure levels of landfill gas on both on- and offsite receptors, both for the undisturbed state of the landfill and conditions occurring during remedial investigations

- o development of information to be used in assessing the performance of the gas control system installed by the City of Seattle as well as information relating to development of additional remedial measures, if required
- o determination if evacuation of nearby businesses/residences is indicated due to ambient air levels of combustible gas that present a serious threat of fire and/or explosion

2.3.2.2 Existing Data

A number of air quality monitoring efforts have been conducted to date at the Midway Landfill site. These have included monitoring of flare gas emissions at the site for use in development of a site safety plan for well drilling and installation activities (Laucks Testing Laboratories, April, 1984), an air quality modeling effort (University of Washington, May 1985), and on-site measurement of combustible gas levels. The results of the monitoring programs indicate that hydrogen sulfide, methane, and a wide variety of organic trace components comprise the landfill gas. The trace components include aromatic compounds as well as many of the "EPA Priority" chlorinated solvents, such as chloroethane, methylene chloride, dichloroethane, trichloroethane, carbon tetrachloride, trichloroethylene, tetrachloroethane, and tetrachlorethylene. Also present in the flare gas are a number of compounds associated with odor problems, including butanoic acid esters and terpenes.

Using results of the sampling of the flare emissions and assumptions regarding flare operations, a standard EPA dispersion model was used by the University of Washington (1985) to estimate offsite impacts of landfill gas emissions. Results of the model predictions were reasonable approximations to observed values for meteorological conditions occurring during sampling.

Further dispersion model predictions were made for the assumed worst-case conditions, which were light northerly winds during slightly stable conditions. These conditions were estimated to occur about 2 percent of the time. Concentrations predicted during these conditions exceeded guideline values for benzene and hydrogen sulfide at off-site locations in ambient air.

Odor problems were addressed in the University of Washington report. Numerous public complaints have been made by individuals residing or working to the east, south, and west of the landfill. Odor complaints have been made during a wide range of meteorological conditions, and may be correlated with the efficiency of past flaring operations.

Measurement of the combustible gas levels both on- and offsite has indicated subsurface and building interior levels greater than 60 percent. The lower explosive limit of methane in air is approximately 4 percent by volume. Combustible gas monitoring has been conducted by, among others, the Seattle-King County Department of Public Health in 1981 and 1985. The 1981 testing found levels of combustible gas in excess of 4 percent in ambient air; the survey monitored 31 homes and 1 business location. As a result of the initial study, the Seattle Solid Waste Utility expanded monitoring efforts. Current monitoring efforts were initiated when explosive levels of methane were measured in a deep gas probe located near the Linda Heights Park well. Ongoing

monitoring of numerous commercial and residential buildings by several agencies continues to indicate explosive levels of combustible gas to the east, south, and west of the landfill.

2.3.2.3 Sample Collection and Analysis Rationale

The air quality investigation will include the following work elements:

- o Source monitoring of the City of Seattle gas control system flare (point source)
- o Source monitoring of the existing landfill surface prior to final closure (diffuse source)
- o Source monitoring during leachate well installation activities (point source)
- o Ambient air and meteorological monitoring on-site at one fixed monitoring station and one mobile monitoring location on a continuous or semi-continuous basis
- o Ambient air and meteorological monitoring off-site at three mobile monitoring locations on an event basis

Each of these areas of investigation is described in detail in the following sections. Additionally, because of the threat of fire or explosion caused by combustible landfill gas emissions, initial remedial measures (IRM's) have been instituted under the air quality investigation task. The IRM's are described in a technical memorandum "Initial Remedial Measure Recommendations - Midway Landfill", Black & Veatch, August, 1985, and include the use of combustible gas instruments to measure gas concentrations in off-site residential and commercial buildings and the temporary closure of one adjacent business.

A. Source Characterization of Gas Control System and Flare

The City of Seattle has implemented a gas control plan at the Midway Landfill which includes a curtain of gas extraction wells around the perimeter of the landfill attached to a positive pressure blower system and a terminal flare to burn the collected gas. The system is currently operating in a temporary mode with portable blowers and flares at several locations on-site. When the system is completed, the entire collection system will be connected to a single stationary blower and flare system. It is assumed that this system will be in place at the time of remedial air quality investigations.

The gas collection system will be sampled at a downstream collection point which is representative of the homogeneous gas being collected from the entire landfill to determine pertinent landfill gas characteristics including:

- o gas flow rate
- o gas moisture content

- o gas temperature
- o representative organics analysis
- o hydrogen sulfide (H₂S)
- o hydrogen cyanide (HCN)
- o hydrogen chloride (HCl)
- o carbon dioxide (CO₂)

Gas flow rate will be determined from operating characteristics of the gas control system blower equipment when operating in a normal mode. If necessary, a portable manometer will be attached to the system at an appropriate location and gas flow rate calculated from pressure measurements and other gas characteristics. Gas temperature will be measured at an appropriate location in the collection system. Gas flow rate and temperature may be available from sensors which are an integral part of the gas control equipment. Gas moisture content will be measured by obtaining a sample from the collection system at an appropriate location and absorbing water vapor on an appropriate dessicant material.

Chemical characteristics of the raw gas stream will be determined by both field and laboratory analysis of representative gas samples from the gas collection system. Field analysis will include Draeger tube analysis for H₂S, HCN, HCl, and CO₂. Field analysis of organics will be indicated by an organic vapor analysis (OVA) instrument in the chromatographic mode, and a more detailed continuous chromatographic analysis using a self-calibrated portable gas chromatograph attached to the gas collection system. Tenax resin or activated carbon collection tubes will be used to obtain time-weighted gas samples for organics confirmation in a laboratory environment. Samples will also be obtained, using an appropriate air sampling technique, for laboratory confirmation of H₂S and HCN concentrations.

The gas flare will be sampled while operating in a normal mode in a downwind direction, at a distance from the flare determined to be sufficient that combustion is complete and radiant heat low enough that sample probes are not affected by the temperature. Samples taken at this location will be used to characterize the post-combustion gas stream prior to complete diffusion in ambient air. The primary purpose of this sampling technique will be to determine efficiency of the combustion process and detect the presence of any uncombusted organics. Field measurement techniques will include use of detector (draeger) tube, the OVA instrument in survey and chromatographic mode, the self-calibrating portable gas chromatograph in real-time mode, and time weighted carbon/resin collection tubes. Parameter list for organics confirmation will be the same as for the raw gas stream.

Two separate sampling events, including a full suite of field and laboratory measurements, will be conducted for the gas collection system and flare.

B. Characterization of Landfill Diffuse Gas Emission

The City of Seattle master plan for closure of the Midway Landfill includes capping of the entire surface area with a low permeability soil to prevent intrusion of surface water and reduce diffuse gas emissions. The nature and significance of diffuse gas emission from the landfill has not been investigated to date. It is assumed that implementation of the gas control system will reduce diffuse gas emission but no data is available to determine or estimate the effect of the gas collection system. It is also assumed that final capping of the site will not be accomplished prior to the air quality remedial investigation.

Characterization of diffuse gas emission will be accomplished by performing a scan of the entire landfill surface area using OVA type instruments in the survey mode. The landfill will be divided into a matrix of discrete sampling points which will be staked or flagged for the diffuse gas survey. An initial survey will be accomplished with a large sampling matrix (point to point distance of about 100 feet) to determine the gross characteristics of diffuse gas emission. A second survey will be accomplished using a smaller grid of sampling points (point to point distance of 10 to 50 feet) to refine the first survey. If no diffuse gas emission is observed during the first survey, the second survey will not be completed. The diffuse gas surveys will be conducted when wind velocity is minimal, when the gas collection system is operating normally, and while all on-site meteorological and air quality instrumentation is operating.

C. Characterization of Air Emissions During Leachate Well Installation

Procedures as described in the site Health & Safety Plan will be fully implemented during installation of on-site leachate monitoring wells. These procedures include continuous monitoring in the "hot" zone around the drill site for combustible gas concentration, hydrogen sulfide concentration, oxygen concentration, and non-methane organics concentration. In addition to the required procedures and continuous measurements, an OVA instrument will be used in the chromatographic mode to "fingerprint" gas emissions from the leachate well borehole at 20-foot intervals during drilling of each borehole. Additionally, meteorological and air quality instruments on-site will be utilized to estimate ambient air impacts of leachate well drilling activities. Air quality instruments will be programmed to obtain daily time-weighted carbon/resin tube samples in the downwind direction at least twice during the drilling activities. Samples obtained by this method will be analyzed in the laboratory for those parameters in Table 5. The self-calibrating portable gas chromatograph will also be utilized during this period of ambient air measurement to characterize ambient air downwind of the drilling activity on a real-time basis.

D. On-site Meteorological and Ambient Air Monitoring

Studies conducted for the City of Seattle (Univ of Washington, 1985) have suggested further monitoring on-site using an upwind-downwind methodology and a standard air quality dispersion model to further characterize ambient air quality and enable prediction of "worst case" off-site air quality constituent concentrations for specified meteorological conditions. Procedures for on-site ambient air monitoring will utilize the recommended methodology to further define on-site ambient air quality during various meteorological and field

activity conditions including the following:

- o critical or "worst case" wind direction and velocity as indicated by the Univ of Washington researchers.
- o representative easterly wind direction and velocity (to the east)
- o representative southerly wind direction and velocity (to the south)
- o representative westerly wind direction and velocity (to the west)
- o during on-site leachate activity and well installation activity
- o during on-site diffuse gas emission survey activity
- o during normal gas control system flare conditions
- o during flare-out gas control system conditions

To accomplish controlled on-site ambient air monitoring during these conditions, a complete remote-operated meteorological station will be installed on-site to obtain local meteorological data including: wind direction and velocity, dry and wet-bulb temperature, barometric pressure, precipitation, and pan evaporation. Continuous or semi-continuous data will be collected by meteorological instruments as necessary during the entire period of the remedial investigation. Data will be collected by recording pen or digital magnetic tape methods as appropriate.

The wind direction/velocity instrument will be attached to a dedicated portable computer which can be used to trigger on-off states for other instruments including an ambient air gas sampler or portable gas chromatograph. The attached air sampler will collect air samples as programmed (wind direction or time-weighted basis) on carbon/resin collector tubes. The portable self-calibrating gas chromatograph when triggered will collect and analyze real-time ambient air samples.

Two additional meteorological/air quality sampling stations as described above (wind direction and velocity only) will be utilized as mobile ambient air quality stations to obtain simultaneous air quality data downwind of the master station. One of these satellite monitoring stations will be installed at appropriate on-site downwind locations during sampling and monitoring events. Samples of ambient air will be collected on carbon/resin collector tubes in the same manner as at the master monitoring station.

Sample sets will be collected for laboratory analysis using carbon/resin tubes as specified below for the proposed monitoring events:

Event	Monitoring Station	
	Master	On-site Satellite
"Worst Case" Wind Direction & Velocity	2 sets	2 sets
Easterly Wind Direction & Velocity	1 set	1 set

Southerly Wind Direction & Velocity	1 set	1 set
Westerly Wind Direction & Velocity	1 set	1 set
Leachate Well Installation	2 sets	2 sets
Diffuse Gas surveys	1 set	1 set
Normal Flare Conditions	1 set	1 set
Flare-out Conditions	1 set	1 set

All samples will be desorbed and analyzed in the laboratory for the parameters listed in Table 5. Simultaneous portable GC measurements will be made on a real-time basis during selected events at either the master or satellite monitoring stations.

E. Off-Site Meteorological and Ambient Air Monitoring

A satellite meteorological/air quality station including wind direction and velocity and an automated air sampling assembly will be installed at appropriate off-site locations to the east, south, and west of the Midway Landfill to obtain off-site air samples in coordination with the overall air quality investigation. Samples will be collected in the same manner as for on-site air monitoring stations. Three discrete events will be monitored in a sequential manner as follows:

Event	Number of Samples
Easterly Wind Direction & Velocity	1 set
Southerly Wind Direction & Velocity	1 set
Westerly Wind Direction & Velocity	1 set

The duration of sampling events will be programmed to take into account the expected low concentrations of any landfill gas constituents with distance from the landfill.

Meteorological and air quality data will be collected continuously or semi-continuously during the duration of the overall remedial investigation. Meteorological data collected during this period will be correlated statistically with simultaneous data collected at the nearby SEATAC airport. It will then be possible to utilize the long term data base for the SEATAC airport to estimate meteorological conditions for Midway Landfill for events other than those directly measured. These comparisons will be fed as input data to the established air quality model using actual or simulated air quality data to predict a wide range of off-site air quality scenarios, as appropriate.

2.4 IDENTIFICATION OF RECEPTORS

2.4.1 Receptor Field Investigation

2.4.1.1 Objectives

The objectives of this portion of the field investigation will be to identify those populations which are exposed to hazardous substances or conditions emanating from the Midway Landfill site. The objectives include the

identification of the types of populations, sizes, and distribution of the populations at risk.

2.4.1.2 Existing Data

The receptor populations can be divided into two broad groups including human population and wildlife resources (including flora and fauna). The draft Environmental Impact Statement for Closure - Midway Landfill completed by the City of Seattle, while addressing closure alternatives, identified on-site and off-site vegetation and wildlife resources within the general remedial investigation study area. The Seattle-King County Department of Public Health provided a list of those residences that have been monitored for combustible gas levels in the Midway area.

2.4.1.3 Data Collection and Analysis Rationale

During the data collection phase of the receptor field investigation, information will be developed describing the number of people in the area who may be at risk from the following factors:

- o gas migration
- o exposure to airborne hazardous substances
- o exposure to or consumption of leachate-contaminated groundwater

The number of employees at nearby businesses will be determined. A review of the vegetation and wildlife inventory included in the Midway Landfill draft Environmental Impact Statement will be conducted to determine the adequacy of the existing data base for evaluating natural resource receptors. Planning documents available from local and state agencies will be reviewed to determine the existing population density within the study area, population movement patterns, and exposure potential. Future growth and development trends will also be reviewed and assessed with respect to potential for new receptors to emerge in the study area.

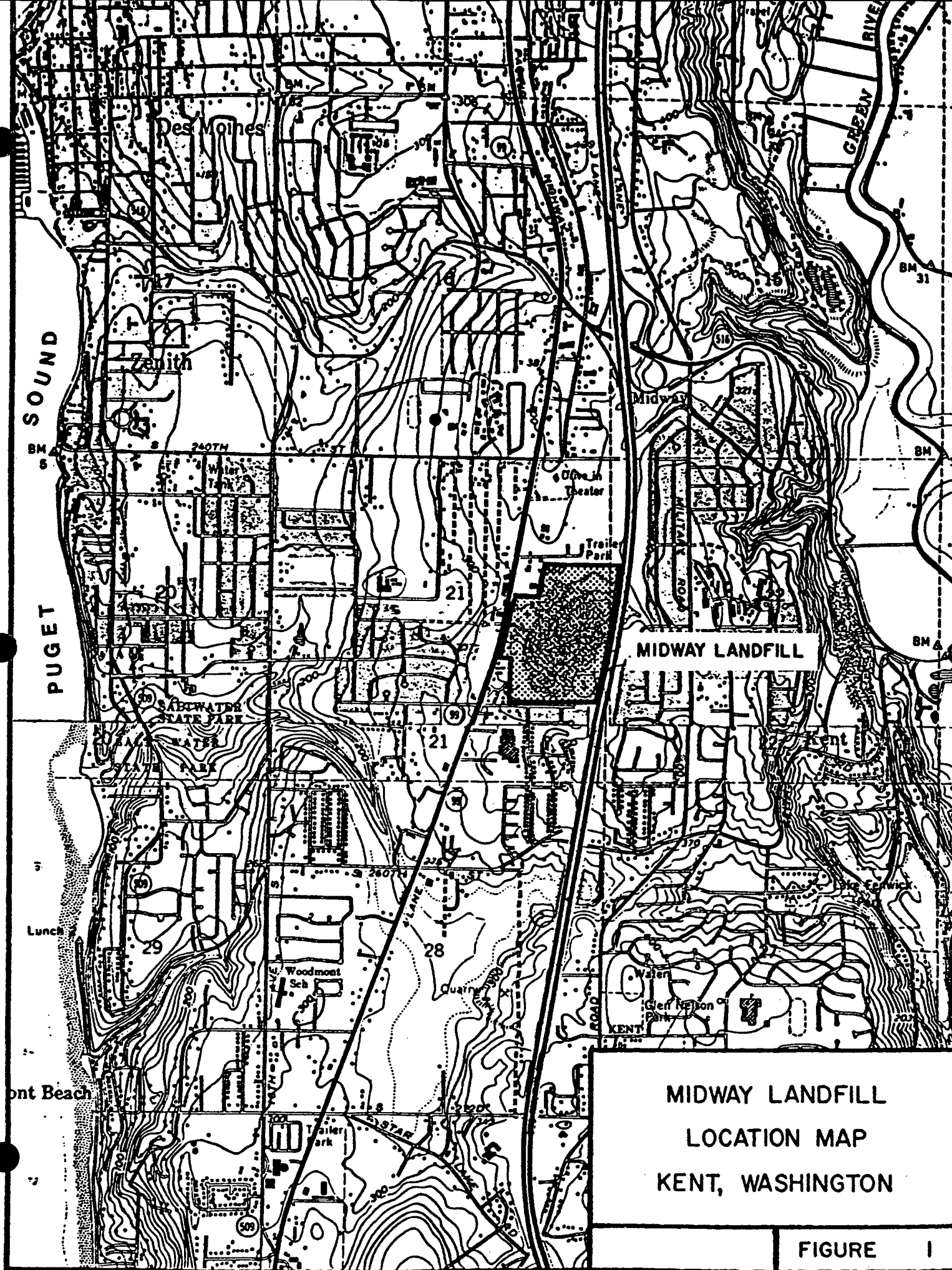


FIGURE 1

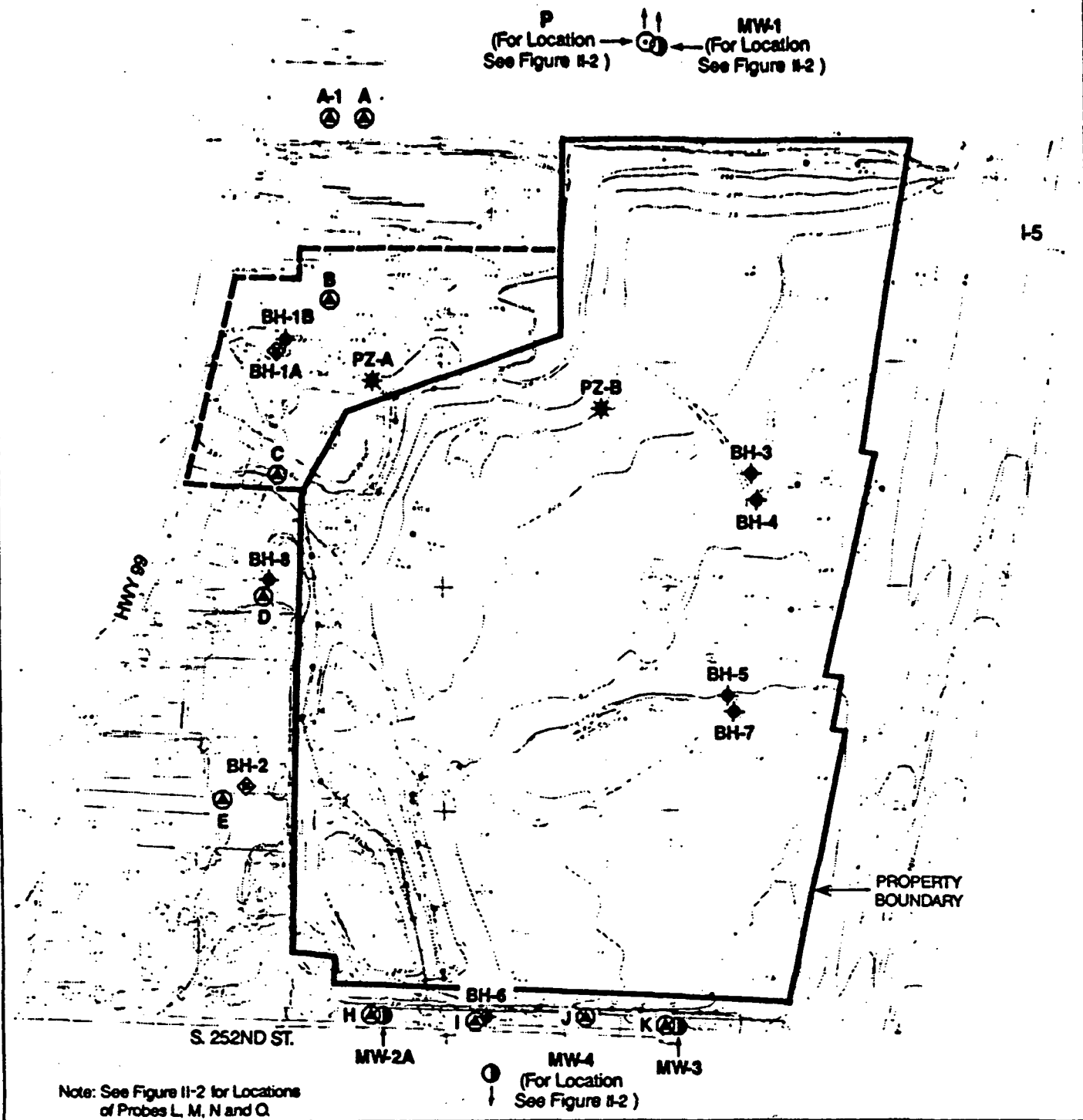
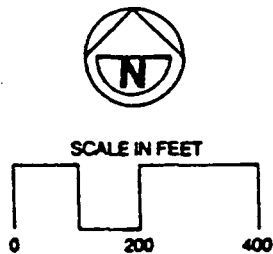


FIGURE 2

LOCATION OF EXISTING
MONITORING WELLS,
LEACHATE WELLS,
AND GAS PROBES



- ★ Piezometers Installed Prior to 1982
- ⊙ Gas Probes Installed in 1985
- ◆ Gas Probes Installed in 1982
- Monitoring Wells Installed in 1985
- ◆ Monitoring Wells or Piezometers Installed in 1982

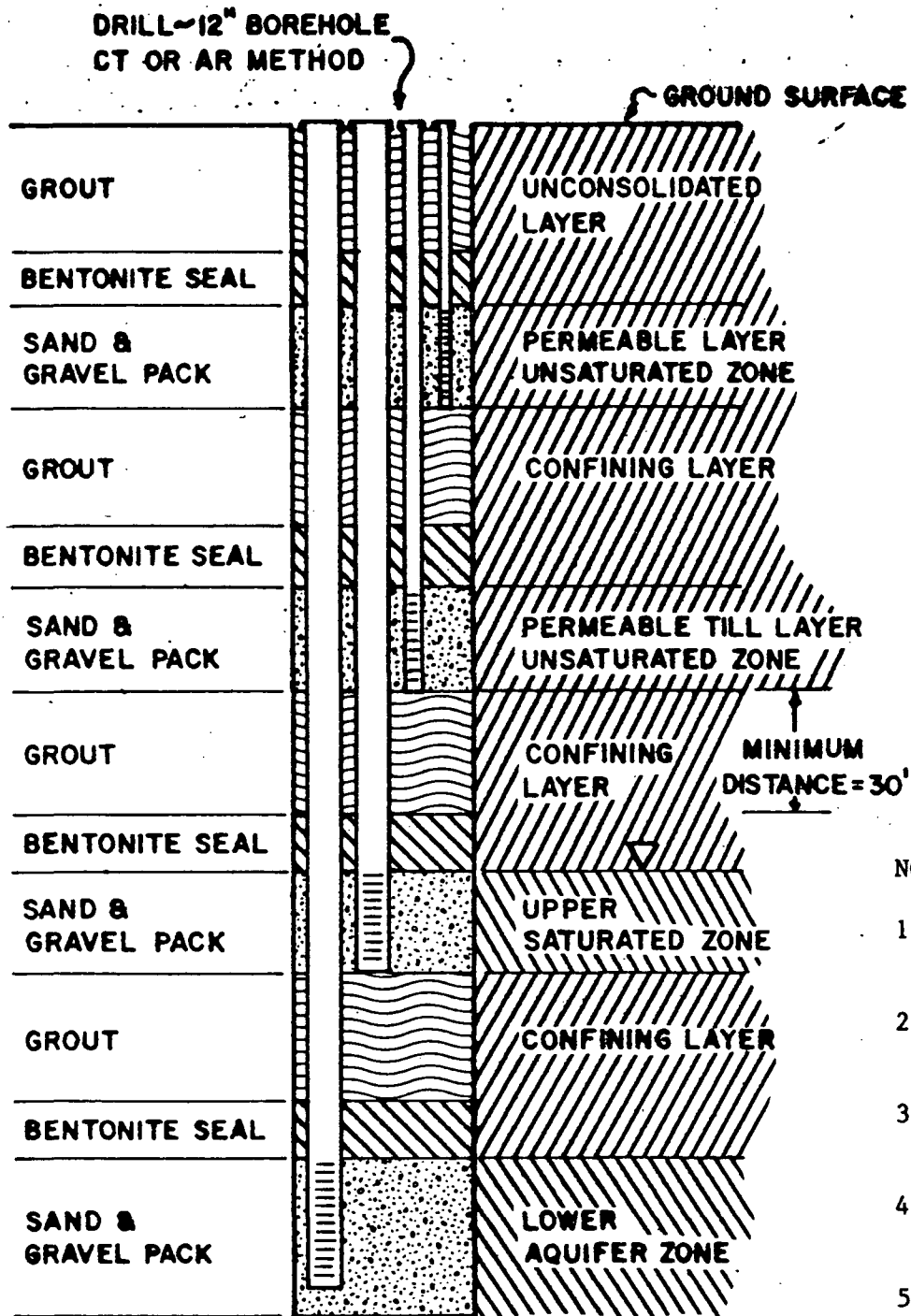


FIGURE 4

**TYPICAL CLUSTERED
WELL/PROBE INSTALLATION**

NO SCALE

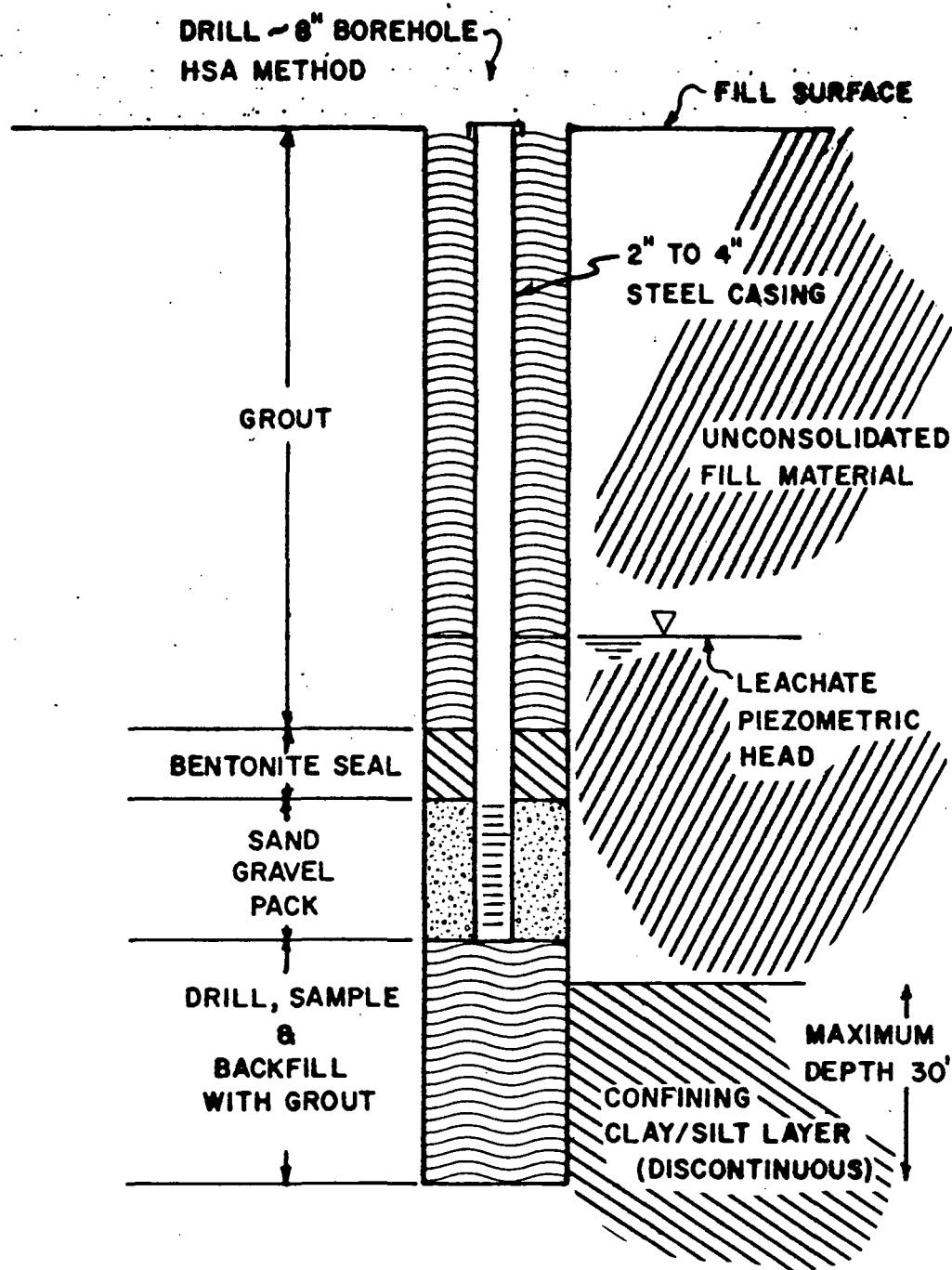
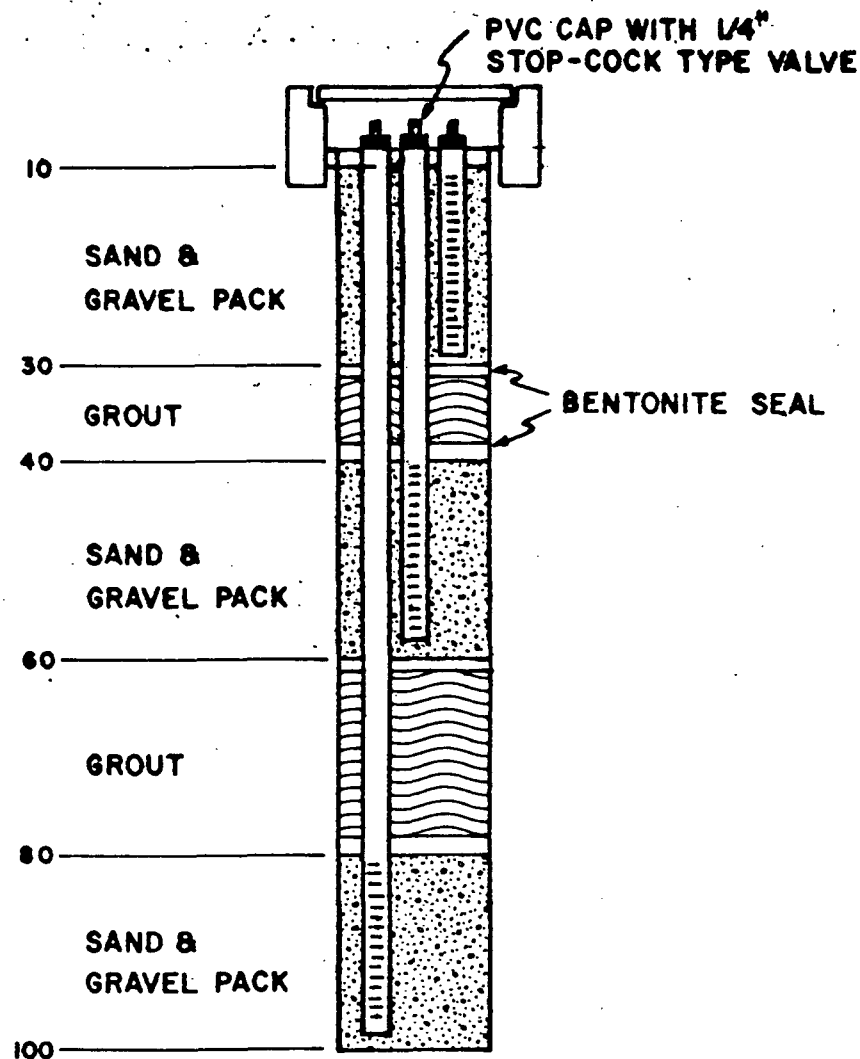


FIGURE 5

**TYPICAL LEACHATE WELL
INSTALLATION**
NO SCALE

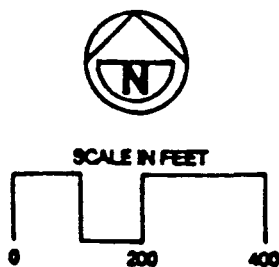
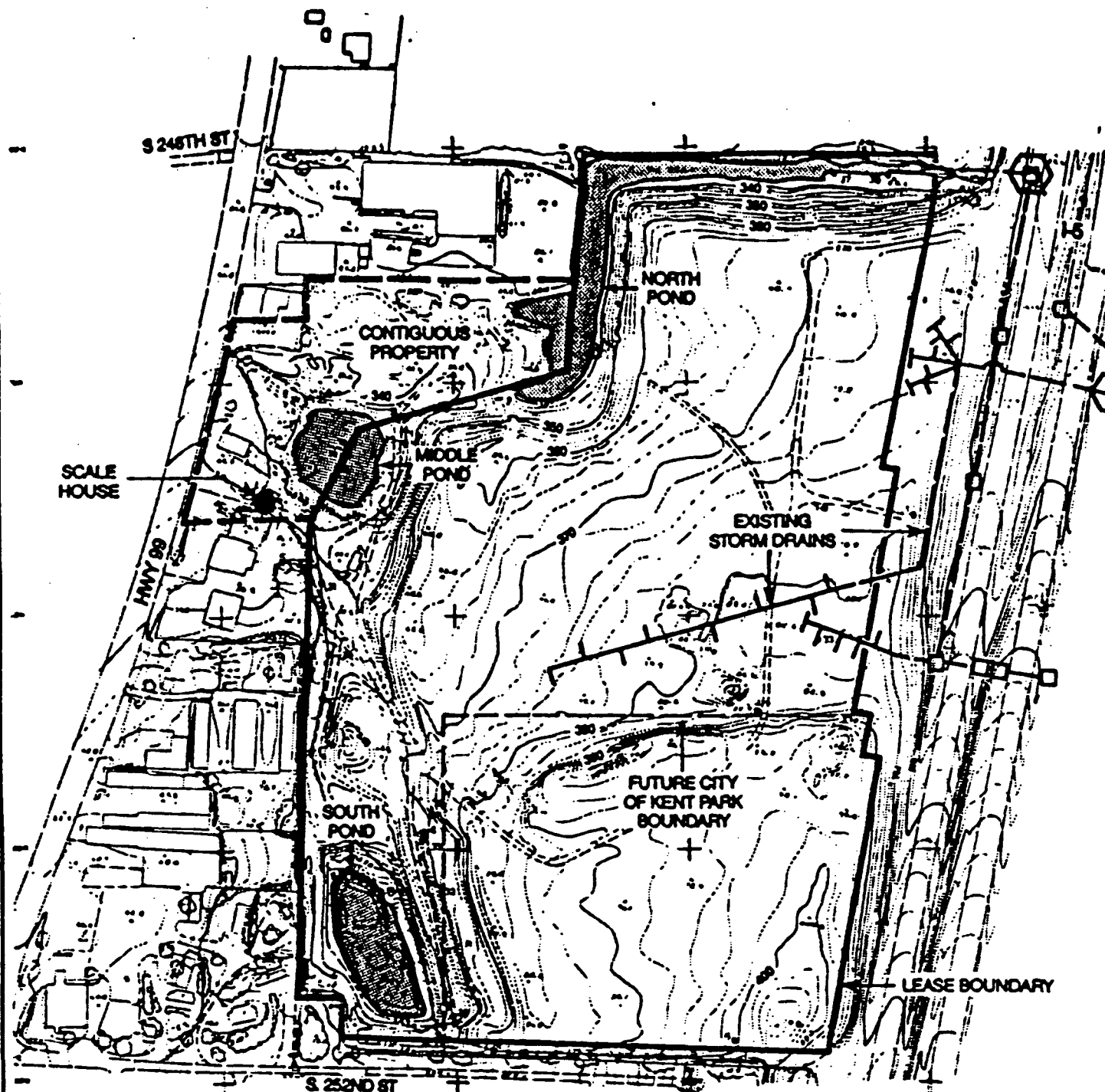


NOTES:

ALL PROBES CONSTRUCTED WITH 1/2 TO 3/4 INCH ID SCH 80 THREADED PVC CASING. SCREEN WILL BE THREADED PVC WITH 0.02 INCH SLOTS.

FIGURE 6

**INTERMEDIATE DEPTH
GAS PROBE INSTALLATION
NO SCALE**







-  Monitoring Location
-  Storm Water Inlet
-  Drain Field Line
-  Existing Drainage Lines

FIGURE 7
PROPOSED STORM WATER
MONITORING LOCATIONS

TABLE 1
APPROXIMATE DEPTHS AND SCREENED INTERVALS
FOR
PROPOSED GROUNDWATER AND LEACHATE MONITORING WELLS

WELL NUMBER	ESTIMATED DEPTH TO WATER (FT)	APPROXIMATE WELL DEPTH (FT)	APPROXIMATE SCREEN INTERVAL (FT)	WORK PHASE
W1 (d,p)	55	95	50-65; 85-95	1
W2 (d,p)	90	130	85-100; 120-130	1
W3 (d,p)	130	170	125-140; 160-170	1
W4	>175	210	200-210	1
W5 (d,p)	120	160	115-130; 150-160	1
W6	150	190	180-190	1
W7	100	110	95-110	1
W8	95	160	150-160	1
W9 (p)	50	60	45-60	2
W10 (p)	80	90	75-90	2
W11 (d,p)	85	125	80-95; 115-125	1
W12 (p)	105	115	100-115	2
W13 (d,p)	140	180	135-150; 170-180	2
W14 (p)	220	230	215-230	2
W15 (d)	180	190	175-190; 210-220	1
W16	125	135	120-135	1
W17	80	90	75-90	2
(W17 shown on site map but is not included in proposed scope of work, will be installed at a later date if needed to provide additional data)				
L1	40	70	35-50	1
L2	80	110	75-90	1
L3	70	100	65-80	1

d = dual completion

p = includes gas probe(s)

TABLE 2
APPROXIMATE DEPTHS AND SCREENED INTERVALS
FOR
PROPOSED GAS PROBES

GAS PROBE NUMBER	ADJACENT GW WELL	APPROXIMATE DEPTH (FT)	APPROXIMATE SCREEN INTERVALS (FT)	WORK PHASE
G1	W1	55	10-55	1
G2		100	10-50; 60-100	1
G3	W2	90	10-40; 50-90	2
G4		100	10-50; 60-100	2
G5	W3	100	10-50; 60-100	1
G6		100	10-50; 60-100	2
G7		100	10-50; 60-100	2
G8	W14	100	10-50; 60-100	2
G9	W5	100	10-50; 60-100	1
G10		100	10-50; 60-100	2
G11	W13	100	10-50; 60-100	2
G12	W12	100	10-50; 60-100	2
G13	W11	85	10-40; 50-85	1
G14	W10	80	10-40; 50-80	2
G15		55	10-55	2
G16	W9	50	10-50	2

See Table 1 for information on groundwater wells and leachate wells.

TABLE 3

LABORATORY ANALYSIS PLAN
FOR
GROUNDWATER AND LEACHATE MONITORING WELLS

PARAMETER	UNITS	NO. SAMPLES
*pH	pH	3
Temperature	oC	3
Conductivity	mmhos	3
*Boron	mg/l	3
Calcium	mg/l	3
Magnesium	mg/l	3
Sodium	mg/l	3
Potassium	mg/l	3
Iron	mg/l	3
Manganese	mg/l	3
Carbonate	mg/l	3
Bicarbonate	mg/l	3
*Sulfate	mg/l	3
*Sulfide	mg/l	3
*Chloride	mg/l	3
Fluoride	mg/l	3
Total Dissolved Solids	mg/l	3
*Total Organic Carbon	mg/l	3
Ammonia Nitrogen	mg/l	3
Nitrate Nitrogen	mg/l	3
Total Kjeldahl Nitrogen	mg/l	3
Hardness	mg/l	3
*Alkalinity	mg/l CaCO ₃	3
Biochemical Oxygen Demand (BOD-5)	mg/l BOD-5	3
*Chemical Oxygen Demand	mg/l	3
*Total Organic Halogen (TOX)	ug/l	3
Priority Pollutants		

Metals		
(Sb, As, Se, Ag, Th)	ug/l	3
(Be, Cd, Cr, Cu, Ni, Pb, Zn)	ug/l	3
Acid Extractables	ug/l	3
Base Neutrals	ug/l	3
Pesticides	ug/l	3
*Microtox	% dim.	3

Note: 22 new wells, 12 existing wells, 3 existing leachate, and 2 off-site wells to be sampled 3 times each.

TABLE 4

LABORATORY ANALYSIS PLAN
FOR
STORMWATER MONITORING

PARAMETER	UNITS	NO. SAMPLES
pH*	pH units	12
Specific Conductance*	mmhos	12
(B,Ca,Mg,Na,K,Fe,Mn,S04)	mg/l	2
S02	mg/l	2
Fluoride	mg/l	2
Total Dissolved Solids*	mg/l	12
Total Suspended Solids*	mg/l	12
Total Kjeldahl Nitrogen	mg/l	2
Alkalinity	mg/l CaC03	2
Hardness	mg/l	2
BOD5	mg/l BOD5	2
Chemical Oxygen Demand (COD)*	mg/l	12
Total Organic Halogen (TOX)	ug/l	2
Priority Pollutants		
Metals	ug/l	2
Acid Extractables	ug/l	2
Base Neutrals	ug/l	2
Pesticides	ug/l	2

Note: Based on sampling 2-24 hour storm events, with "*" parameters to be used as indicators of runoff quality, at 4 hour sampling frequency.

TABLE 4B

LABORATORY ANALYSIS PLAN
FOR
LANDFILL LEACHATE SEEPS

<u>PARAMETER</u>	<u>UNITS</u>	<u>NO. SAMPLES</u>
<u>Conventionals</u>		
pH	pH units	20-25
Specific Conductance	mmhos	20-25
BOD5	mg/l BOD5	20-25
COD	mg/l	20-25
TDS	mg/l	20-25
TSS	mg/l	20-25
Boron	mg/l	20-25
Fecal coliform*	#/100 ml	20-25
<u>Priority Pollutants</u>		
Metals	mg/l	20-25

*Analyzed to determine septage seeps

TABLE 4C

LABORATORY ANALYSIS PLAN
FOR
SURFACE SOILS AT SEEP LOCATIONS

PARAMETER -----	UNITS -----	NO. SAMPLES -----
Grain size analysis		15
pH (saturated paste)	pH units	15
Conductivity (saturated paste)	mmhos	15
Priority Pollutants -----		
Metals	mg/kg	15
Acid Extractables	mg/kg	15
Base/Neutrals	mg/kg	15
Pesticides	mg/kg	15

TABLE 5

LABORATORY ANALYSIS PLAN
FOR
AIR QUALITY SAMPLES USING DETECTOR TUBES

PARAMETER	NUMBER OF SAMPLES	
	Ambient Air (a)	Gas Probes (b)
1,2-Dichloroethane	25	15
Benzene	25	15
Carbon tetrachloride	25	15
Isooctane	25	15
Trichloroethylene	25	15
Toluene	25	15
Ethylhexane	25	15
Xylene	25	15
Limonene	25	15
Methylene Chloride	25	15

Note: Parameter list based on historical flare sampling.

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TARGET SHEET

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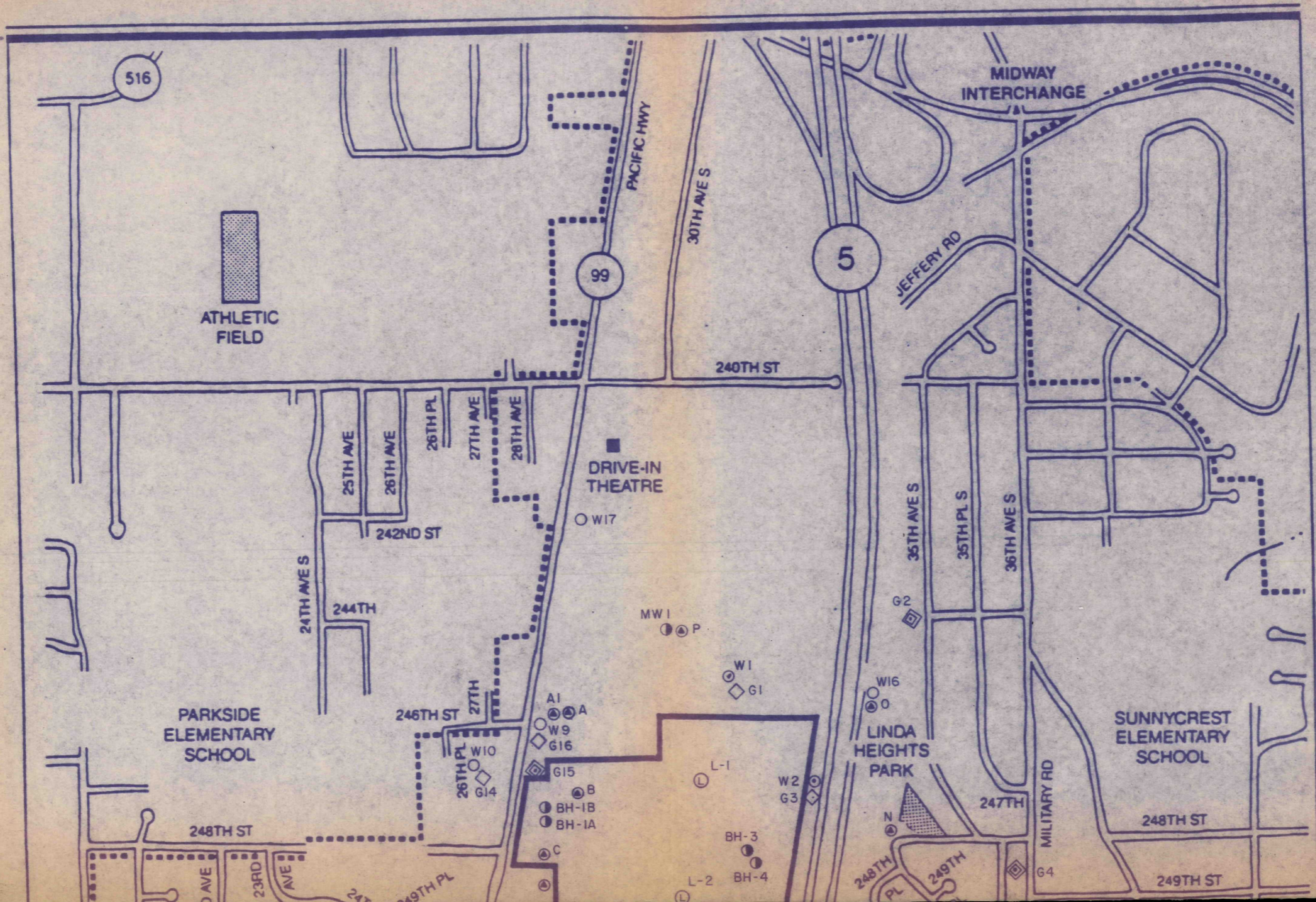
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FIG 3



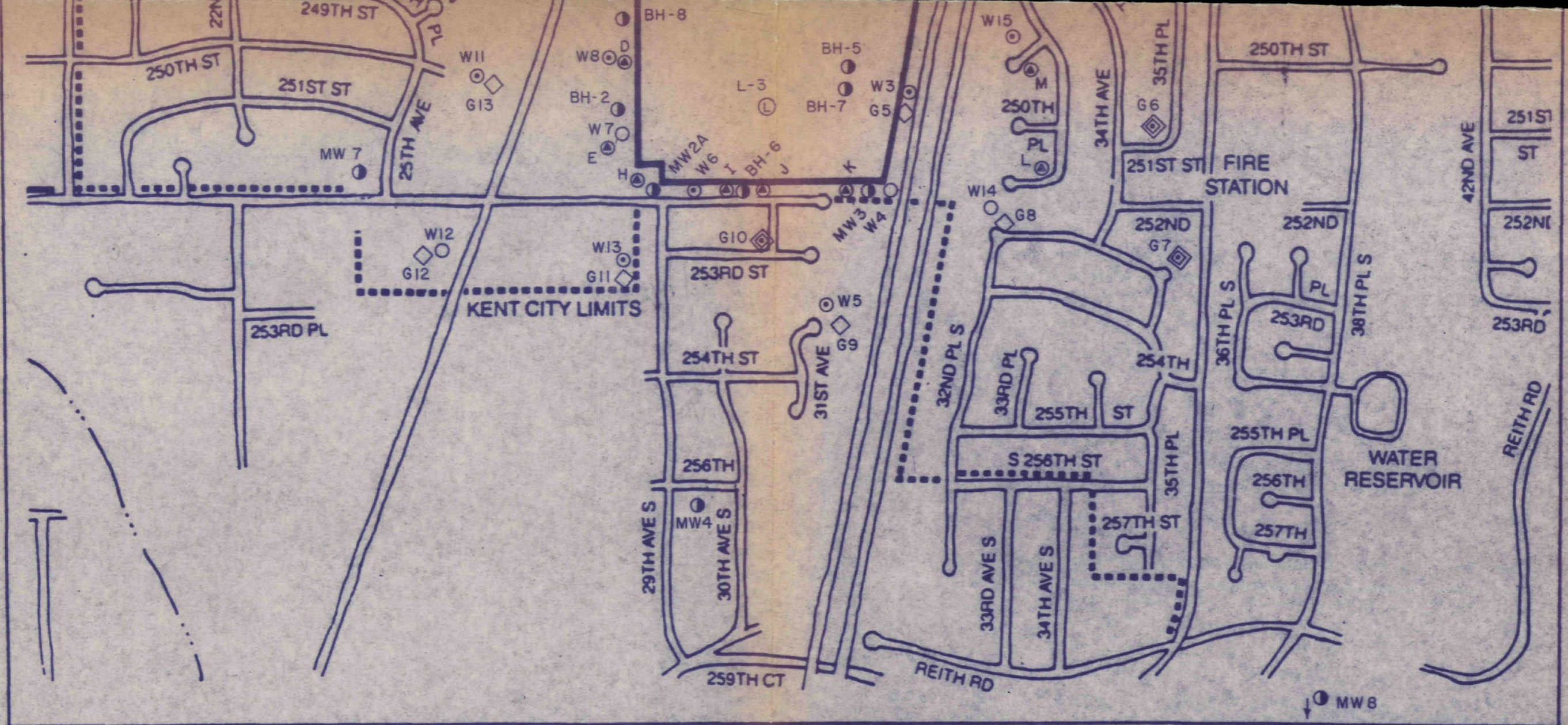
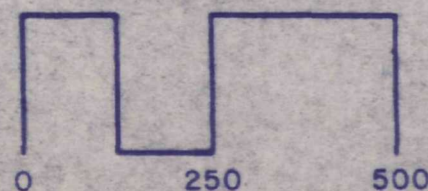


FIGURE 3

LOCATIONS OF MONITORING
WELLS, LEACHATE WELLS,
AND GAS PROBES

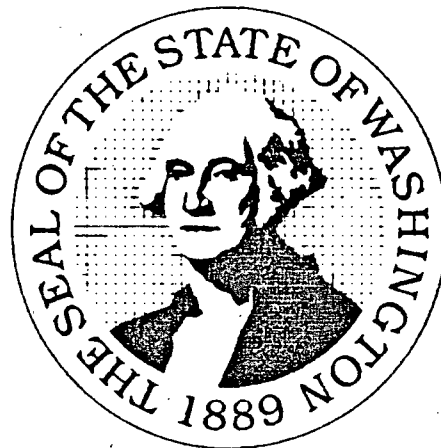


SCALE IN FEET



- Existing Gas Probes
- ◇ Planned Gas Probes
- ◆ Planned Gas Probe Clusters
- Existing Groundwater Monitoring Wells
- Planned Groundwater Wells
- ⊙ Planned Dual - Completion Groundwater Wells
- Ⓛ Planned Leachate Wells

Neil Thompson



REVISED DRAFT
PROJECT WORK PLAN FOR RI FIELD ACTIVITIES

MIDWAY LANDFILL

KENT, WASHINGTON

DECEMBER 5, 1985

**State of Washington
Department of Ecology
Office of
Hazardous Substances and Air Quality Control**

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1.0 EXECUTIVE SUMMARY

This revised draft project work plan for the implementation of remedial investigation (RI) field activities at Midway Landfill was prepared under contract C-85075 with the State of Washington, Department of Ecology. Authorization for the production of this work plan has been made under Midway Landfill work assignment MDLF-2, as amended.

The strategy utilized to develop this work plan is consistent with the Midway Landfill Forward Planning Document (Black & Veatch, March 1985) and the revised final RI Sampling and Analysis Plan (Black & Veatch, December, 1985). Data obtained during this phase of the overall remedial investigation field activities will be evaluated in detail, and may result in additional RI field activities. Additional RI field activities may include the installation of additional monitoring wells or gas probes to provide a more comprehensive data base for purposes of developing remedial actions.

This work plan establishes a scope of services to be performed with an estimated budget of \$____,000 and a completion schedule of approximately 32 work weeks after receipt of the work assignment authorization from Ecology. This project consists of the major field investigation phase of the remedial action investigation to be conducted at the Midway site. Prior to initiation of this work effort, an initial series of gas probes are being installed adjacent to the landfill site to monitor for off-site gas migration. Work completed under this work plan will complement that initial field activity.

1.1 INTRODUCTION

The purpose of this major field activity phase of the remedial investigation for Midway Landfill is to obtain sufficient data to identify the magnitude and extent of contaminant and gas migration for subsequent assessment of remedial action alternatives during the feasibility study. The collection and review of all data will be done in a legally defensible manner in accordance with CERCLA guidelines. The investigation will consist of activities to be conducted in four major areas: geologic investigations, hydrologic investigations, gas migration and air quality investigations, and an investigation to identify receptors. The estimated date of startup for the activities described in this remedial investigation (RI) work plan is January, 1986.

This RI Project Work Plan contains the project description, scope of work, schedule, team assignments, and description of outputs for each of several tasks.

1.2 OBJECTIVE

The technical objectives of the work effort described in this RI Project Work Plan are as follows:

- o define subsurface stratigraphy and geohydrology at the Midway Landfill site
- o define the nature and extent of water, air, and soils contamination at and adjacent to the Midway Landfill site to support a subsequent remedial action feasibility study

- o define the nature and extent of landfill gas subsurface migration adjacent to the Midway Landfill site in support of current Initial Remedial Measures (IRM'S)
- o determine the efficiency of the gas control system implemented at the Midway Landfill site by the City of Seattle
- o expand on the existing technical data to determine adequacy of the proposed City of Seattle final closure plan for Midway Landfill
- o further identify potential off-site contamination receptors adjacent to the Midway Landfill site

Other objectives of this work effort are as follows:

- o conduct all field activities in accordance with legally defensible CERCLA guidelines
- o support past and current efforts by the City of Seattle and other state and local agencies to monitor and close the Midway Landfill site in a cost effective and environmentally sound manner
- o continue an active community relations effort to inform the public and other interested parties of current work status

1.3 BACKGROUND

Detailed background information relating to the Midway Landfill project has been presented in the Midway Landfill Forward Planning document (Black & Veatch, 3/85). Recent developments concerning the detection of significant levels of combustible gas off-site in the vicinity of the landfill have contributed to increased monitoring efforts, including the installation of approximately 65 off-site gas probes to further define the extent and concentration of the landfill gas plume. The City of Seattle Solid Waste Utility has installed an on-site gas collection system and prepared a proposed closure plan for the Midway Landfill site (Draft Environmental Impact Statement for Midway Landfill Closure, City of Seattle Engineering Department, 9/85).

2.0 SCOPE OF WORK

This RI Project Work Plan contains the project description, scope of work, schedule, team assignments, and description of outputs for each of several tasks. Activities that will be included in this work effort are listed below.

- o Development of detailed site plan for remedial investigation (RI) field activities
- o Development of design drawings for wells and gas probes
- o Development of subcontractor specifications and contract documents
- o Implementation of health and safety plan, quality control/quality assurance plan, and sampling and analysis plan during the field activities
- o Monitoring well drilling and installation

- o Leachate well drilling and installation
- o Gas probe drilling and installation
- o Ground survey to record locations of wells, probes, and sampling sites
- o Implementation of ambient air/climatological monitoring
- o Soil, groundwater, surface water, and gas sampling
- o Receptor Identification
- o Data analysis and report preparation
- o Project management
- o Community relations plan implementation

Each of the tasks associated with this work effort is described in greater detail in the following sections.

2.1 TASK 1 PROJECT INITIATION ACTIVITIES

The purpose of this task will be the mobilization of manpower and material resources for all subsequent field activities. A base map of the landfill and surrounding area to be investigated during the RI field activities is currently being prepared from recently obtained WDOT aerial photography. This base map will be reviewed in detail to establish final locations for all drilling and other field installation activity sites. The procurement of rights-of-way for drilling of off-site gas probes and monitoring wells will be the responsibility of the Department of Ecology. Utility locations at each activity site will be the responsibility of the field activities project team. Key activities involved in finalizing preparations for the initiation of field drilling and sampling activities are expected to include:

- 1) Project initiation meeting involving the project engineer, site managers for geotechnical and surface field activities, other key field project team staff, and Ecology management and technical staff
- 2) Finalization of remedial investigation Sampling and Analysis Plan site plan showing proposed drilling locations and meteorological/air quality installation locations in detail on base map
- 3) Review of final site plan by involved agencies (Ecology, WDOT, City of Kent, City of Des Moines, City of Seattle, King County, home/business owners) to identify and resolve potential problems with right-of-way or other sensitive issues
- 4) Approval of the final detailed site plan from comments received during previous steps, including acquisition of all local permits
- 5) Staking of actual drilling sites for gas probes, leachate wells, and groundwater monitoring wells, and utility location marking at off-site locations
- 6) Preparation for implementation of health and safety, quality assurance, and sampling plans, including mobilization of equipment, calibration of monitoring equipment, laboratory coordination to schedule sample shipment and analysis, and any necessary retraining/recertification of field personnel in accordance with Health and Safety Plan requirements

Project initiation activities will be coordinated such that off-site monitoring well and gas probe installation can be initiated as quickly as possible after approval of the detailed site plan. In addition, meteorological and air quality monitoring instruments will be installed on-site as early as possible. Access to some off-site monitoring well and gas probe locations may take longer to complete due to physical barriers or legal considerations. The determination of the exact locations for these more difficult activity sites will be an on-going process under direction of Ecology staff and RI project team representatives.

The project initiation meeting will serve the purpose of finalizing the schedule for field activities and determining final project team organization for field and monitoring activities. Key Ecology and project team staff will conduct a site visit with the purpose of finalizing field activity locations and marking those locations on the base map.

2.2 TASK 2 DEVELOPMENT OF SUBCONTRACTOR DRAWINGS AND SPECIFICATIONS

The purpose of this task is to develop plans, drawings, and specifications for the drilling program, ground survey activities, and specialty air quality instrumentation installation, startup, and consultation. The format used will be suitable for each type of subcontract, and will meet all contract procurement requirements of EPA, the State of Washington, and the Black & Veatch prime contract with Ecology. B&V will develop all contract documents and will assist Ecology in completing procurement requirements. Contents of the documents will include:

- 1) Typical drawings for monitoring well, leachate well, and gas probe installation with appropriate design notes and specification references
- 2) Specifications for all drilling activities including mobilization, drilling procedures, geologic sampling procedures, casing installation and grouting details, and completion details
- 3) Specifications for ground survey activities including tolerances for horizontal and vertical surveys, computational and field note methods, instrument tolerances, and map plotting requirements
- 4) Specifications for air quality monitoring instrumentation installation and startup, including instrument specifications, operating environment, power requirements, support equipment requirements, and maintenance requirements
- 5) General contract clauses, including health and safety, quality assurance/quality control, insurance, and administrative requirements
- 6) Bid forms for submission of subcontractor quotes

Ecology will review the draft contract documents for compliance with all technical and procurement requirements. After Ecology approval is obtained, final contract documents will be used to retain one or more specialty subcontractor(s) and negotiate final subcontractor cost in accordance with federal and state procurement regulations.

2.3 TASK 3 FIELD ACTIVITIES

Remedial Investigation (RI) field activities will include those tasks which involve a one-time or uniquely identified task. The field activities described in this section typically will not include intensive monitoring programs (described in Section 2.4). Field activities that will take place at Midway Landfill are described below and in the revised final RI Sampling and Analysis Plan (Black & Veatch, 12/85).

Organization of field activities will be the responsibility of a geotechnical site manager and a surface activities site manager. The project engineer will provide overall technical and schedule guidance to site managers. Health and safety (H&S) and quality assurance (QA) functions will be the responsibility of a single full-time H&S/QA officer who will work independently of other personnel and will insure that all field activities are in accordance with the site Health and Safety Plan and the Quality Assurance Plan. The site managers and H&S/QA officer will be assisted by staff engineers and scientists from the manpower resources of the field activities project team and specialty subcontractors.

Scheduling of field activities will be a critical project management task during work plan implementation. Scheduling of activities will be the responsibility of the project engineer and will be conducted in accordance with the overall RI Project Work Plan schedule and guidance from Ecology managers.

2.3.1. TASK 3.1 GROUNDWATER MONITORING WELL INSTALLATION

It is anticipated that a total of sixteen new monitoring wells will be installed at nine locations within and adjacent to the landfill. In order to determine if significant differences exist in the water quality between the upper water table and the water beneath the confining layer, six of the wells will be dual completion wells. Additionally, five of the wells will have gas probes within the well borehole. The location of the wells has been tentatively identified in the revised final Midway Landfill Sampling Plan. Sufficient geologic samples will be obtained during drilling to characterize the subsurface stratigraphy. A priority order for installation of monitoring wells has been established to obtain critical geologic and hydrogeologic data as early as possible after initiation of drilling activities. The locations and completion depth of lower priority monitor wells will be modified if necessary to insure that an optimum network of monitor wells is established adjacent to the landfill site.

A full-time geotechnical engineer will provide field supervision of the drilling activities and will review and certify the drillers' record. The geotechnical engineer will be responsible for determining the final depth of well completion, based upon the geological characteristics and relative degree of saturation of the formations. Additionally, the geotechnical engineer will be responsible for the proper installation, grouting, and completion of the casings, screens, gravel packs, and other fill materials. The use of a magnetometer or metal detector will assist in avoiding drilling through buried utility lines or metallic objects (drums, containers) that may present a safety threat. Upon completion of installation of well casings, the wells will be developed. Development will occur after the water level has reached and remained at equilibrium for at least three days. At that time, the well will be purged, evacuating at least 5 well volumes. The process will be repeated

5w wells
16 wells
9 locations

long or
short term
monitoring

prior to sampling. Dedicated bladder-type pumps will be installed at each wellhead for each well, with locking caps.

In addition to the geotechnical engineer, there will be assigned a field supervisor responsible for the implementation of the Health and Safety and QA Plans. This person will be designated as the H&S/QA officer, and will be responsible for the proper calibration, maintenance, and operation of all field instrumentation, as well as the proper handling of all media environmental samples. In the event that unsafe conditions arise that cannot be mitigated using measures outlined in the Health and Safety Plan, the H&S/QA officer will have authority to halt or interrupt drilling activities.

2.3.2 TASK 3.2 LEACHATE WELL INSTALLATION

This task will focus on the drilling and installation of three leachate monitoring wells that will be installed within the landfill material. This task has been designated as a work effort separate from the installation of the groundwater monitoring wells because of potentially greater safety risks, and different drilling and installation techniques. The presence of high levels of landfill gas, potentially under significant pressures, necessitates the provision of additional safety measures such as supplied air and SCBA equipment. A magnetometer or metal detector will be used to avoid drilling into buried containers such as drums. Each leachate borehole will be drilled to a maximum depth of 30 feet below the bottom at the fill. Geologic samples will be taken only from this 30-foot zone below the fill, at 5-foot intervals, as directed by the geotechnical engineer.

A geotechnical engineer will provide supervision of the leachate well drilling and installation. The H&S/QA officer will assume the responsibility for H&S/QA functions, and will be on-site at all times when drilling or installation of leachate monitoring wells is underway. The H&S/QA officer will have complete authority to shut down or interrupt drilling operations should unsafe conditions arise that cannot be mitigated with those measures outlined in the Health and Safety plan.

Once the leachate monitoring wells are installed, development tests will be conducted to purge the wells and prepare them for later sampling. At least one of the leachate wells may be installed with a 4-inch or larger casing to accommodate larger leachate pumps for greater water removal rates. Drawdown tests may be conducted at a later date using this well and appropriate surrounding gas control system extraction wells to estimate a typical drawdown curve for the fill material. Permeability and transmissivity factors would be estimated for the fill using this data. This data base would be used if appropriate in developing leachate removal rates for leachate treatment alternatives during a subsequent feasibility study. Completion of this task would be contingent upon whether satisfactory water level data can be obtained from surrounding gas extraction wells.

2.3.3. TASK 3.3 GAS PROBE INSTALLATION

During this task, six gas probe clusters will be installed adjacent to the landfill area. These probe locations will be selected to complement the data obtained from the initial installation of approximately 65 shallow gas probes which are being implemented under a separate work plan and the location of similar probe clusters installed by the City of Seattle. Locations will be

finalized by the geotechnical site manager in consultation with landfill gas experts assigned to the field activities project team and Ecology project managers during project initiation activities. The securing of rights-of-way for off-site probe installation will be the responsibility of Ecology. Probes will consist of two or three clustered probes per location to assess the extent of gas migration with depth and stratigraphy.

In addition to gas probe clusters, gas probes will be installed in the same borehole with groundwater monitor wells in some locations where both types of data are needed. Gas probes will be screened above the highest water table at these locations and will function in the same way as other gas probe clusters. Two probes will be the maximum number of installations in these boreholes to minimize the potential for seal failures between the screened probe elevations or between the probes and groundwater monitoring well screen elevations. It is anticipated that five to seven monitor well installations will include gas probe installations of this type.

During drilling and installation of the gas probes, the geotechnical site manager will provide drilling supervision and will be responsible for geotechnical sample collection, drilling procedures, installation procedures, and gas probe completion. The geotechnical site manager will be assisted by a landfill gas expert who will be responsible for selecting final probe depths and other decisions related to optimization of the subsequent gas probe monitoring program. The H&S/QA officer will be responsible for Health and Safety and Quality Assurance activities associated with gas probe drilling and installation.

2.3.4. TASK 3.4 GROUND SURVEY

During this task, the locations and elevations of all groundwater monitoring wells, leachate wells, gas probes, and leachate seep sampling sites will be surveyed. Additionally, this work effort will encompass the surveying of the gas probes (approximately 65) installed under the "Project Work Plan for Gas Probe Installation, Midway Landfill Remedial Investigation, Kent, Washington (B&V, September 1985) and operable monitor wells, extraction wells, and gas probes installed under the direction of the City of Seattle. The surveying of all sample locations is necessary to accurately document their location in accordance with CERCLA guidelines, and to provide information to be used in the design of remedial action alternatives during a subsequent feasibility study. It is expected that one subcontract survey crew will be used to complete the field portion of this task. Survey computations and plotting of locations and elevations on base maps will be based on field survey notes.

2.3.5 TASK 3.5 SURFACE WATER INVESTIGATION

During this task, storm water sampling instrumentation will be installed at two locations as indicated in the revised final RI sampling Plan. Two automated storm-triggered stormwater samplers will be installed, along with continuous flow recorders to obtain a data base for I-5 inflow into the base of the landfill. A detailed storm sewer review will be conducted for the vicinity surrounding the landfill to accurately determine storm sewer drainage patterns from available storm sewer maps and to document flow conditions after rainfall events. Staff gages will be installed at the north and middle ponds on the landfill site. The locations of surface seeps in the study area surrounding the landfill will be documented and mapped for subsequent sampling and water level measurements.

2.3.6. TASK 3.6 METEOROLOGICAL/AIR QUALITY STATION INSTALLATION

Two on-site meteorological/air quality stations will be installed during this task, and three off-site satellite station locations will be identified for subsequent station installation. The two on-site stations will consist of (1) a master meteorological station which continuously records wind direction and velocity, barometric pressure, dry and wet-bulb temperatures, precipitation and pan evaporation, and (2) a satellite station which records only wind direction and velocity. Both stations will be equipped with programmable air quality sampling stations consisting of a programmable portable computer, air sampling pump, and Tenax resin/activated carbon gas collection tubes. Installation will be completed as quickly as possible after field activities are initiated in accordance with the detailed site plan. The information gathered from the stations will assist in planning day-to-day field activities, by providing information concerning wind speed and direction, relative humidity, barometric pressure, temperature, rainfall, and evaporation rates. These stations will also be used to obtain event-driven on-site air quality data during the field activity period. The stations will be installed at locations to be determined by the project team surface activities site manager, with advice from project team and subcontractor meteorological and air quality experts. A specialty subcontractor may be retained to assist in identification of station locations. The subcontractor will install, test, and start up the instrumentation, provide consultation, and collect air quality samples during

Completed 12/1/85

the RI field activities and monitoring periods. An additional satellite meteorological/air quality station, identical to the on-site satellite station, will be installed at three locations in a sequential manner to obtain off-site meteorological/air quality data in accordance with the overall air quality investigation monitoring plan. These locations will be to the east, south, and west of the landfill site and will be selected during detailed site planning activities.

Data obtained from meteorological and air quality instruments will be used in assessing both on-site and off-site air quality impacts.

2.3.7 TASK 3.7 RECEPTOR INVESTIGATION

The identification of potential receptors will be completed during this task. Receptors are defined as those human and other life forms on and adjacent to the landfill which may be detrimentally affected by environmental problems created by the presence of the landfill including gas migration, groundwater or surface water contamination, soil contamination, or air quality contamination. Included in this work effort will be a detailed water well survey to determine if there are any operational wells that are at risk from groundwater contamination, and a review of planning documents from the cities of Kent and Des Moines, and Seattle/King County to determine future development plans. A review of the vegetation and wildlife inventories included in the City of Seattle Environmental Impact Statement for Closure, Midway Landfill will be made. Results obtained from the combustible gas monitoring efforts currently underway will be used to profile the size and distribution of the population at risk from landfill gas presence. Potential risks to receptors will be reviewed synoptically by preparing geographic distribution maps of problem issues and overlaying these on the study area base map.

Sensitive receptors

2.4. TASK 4 MONITORING ACTIVITIES

An intensive monitoring effort will be undertaken in conjunction with the geotechnical drilling and equipment installation tasks and other field activities conducted at the Midway Landfill site. The monitoring program will be conducted on a schedule which is intended to provide time correlated data for multi-media environments, with an objective of providing basic RI-related information on the hydrologic cycle, climatic and air quality cycle, groundwater hydrology, leachate movement, and gas migration dynamics related to the Midway Landfill site.

During this work effort, monitoring of newly installed groundwater monitoring and leachate wells, gas probes, and air quality will be conducted. Additionally, existing wells and probes will be sampled, as well as surface water quality. The monitoring efforts are further described below.

2.4.1 TASK 4.1 GROUNDWATER AND LEACHATE WELL MONITORING

The groundwater monitoring wells and the leachate wells will be sampled a minimum of three times during the RI monitoring period. Water level measurements will be made weekly using an electronic well level indicator. Each of the newly installed wells will be sampled, as will selected on-site and off-site groundwater and leachate monitoring wells. It is anticipated that at least two off-site, privately owned wells will also be sampled during this work effort. One of the sampling events is scheduled to occur in association with wet weather events, and two during dry weather conditions. An appropriate antecedent condition will be selected for each sampling event. A two-member

dedicated pumps

Timing?

team will be used to obtain the samples, with one team member devoted to sample handling (preparation of sample containers as appropriate, filling of containers, completion of chain of custody forms, packing and shipping); the other team member will be responsible for purging of the wells and the actual sample procurement, and in-situ parameter measurement as outlined in the sampling plan. The site H&S/QA officer will oversee this activity to insure that all provisions of the Health and Safety and Quality Assurance Plans are followed.

2.4.2 TASK 4.2 GAS PROBE MONITORING

This task will focus on sampling six new gas probe clusters and monitor well gas probes installed under this work plan, approximately 65 shallow probes being installed under a separate Midway Landfill work plan, and selected probes which have been installed in and near the landfill in 1985 by the City of Seattle, Solid Waste Utility. Sequential monitoring rounds will begin immediately after completion of probe installation with a complete scan of all probes, and will continue with partial scans consisting of approximately 50 percent of all probes during the initial monitoring period. Monitoring will include combustible gas concentration, O₂ level, CO₂ level, H₂S level, and volatile organics semi-quantitative chromatographic analysis. The equivalent of three complete rounds of gas probe sampling will be completed during this task. One two-man crew, trained previously, will complete this task, with supervision provided by a project team gas migration expert and H&S/QA officer.

2.4.3 TASK 4.3 AMBIENT AIR MONITORING

Automated collection of meteorological and ambient air quality data will be initiated as early as possible during the RI field activities period and will be closely coordinated with other ongoing RI field activities. Air quality sampling efforts during the field activities monitoring period will be based upon an extension of the landfill gas source and ambient air monitoring work performed on-site by the University of Washington (University of Washington, July, 1985). Special attention will be given to verifying critical meteorological conditions suggested in the university researchers' report. Data will be obtained in a manner to facilitate input into the air quality dispersion model developed for the site. An on-site automatic master weather station will be installed to collect meteorological data as early as possible during the field activities period and will continue to operate throughout the field activities monitoring period. Parameters to be measured will include wind speed and direction, dry and wet-bulb temperature, humidity, barometric pressure, rainfall, and evaporation. Sampling pumps using resin/charcoal collector tubes will be installed at an upwind and a downwind site. The pumps will collect time-weighted samples under microprocessor control during the time that drilling activities are taking place on site, and will also operate during other meteorological event-driven monitoring periods. In addition, real time organic vapor analysis will be conducted using a portable continuous-calibration gas chromatograph linked to the automated air sampling systems on the master and satellite meteorological stations. Organic vapor analysis will also be utilized to gather data on diffuse gas emissions from the landfill surface, and from the gas collection and flare sources associated with the City of Seattle gas control system.

Source monitoring of the gas control system will be conducted to determine the components of the landfill gas at the source and ambient air emissions from the gas control system flare. The gas collection system will be sampled at a downstream collection point which is representative of the homogeneous gas being collected from the entire landfill area. Data collected will include gas flow rate, gas moisture content, gas temperature, hydrogen sulfide, hydrogen cyanide, hydrogen chloride, carbon dioxide, and representative organics. The City of Seattle Engineering Department staff will be consulted to coordinate the collection of this data during normal operation of the gas extraction system. Similarly, the gas control system flare will be sampled in an appropriate manner such that typical emissions from the flare combustion process will be monitored during both normal operation and flare-out conditions. The flare will be sampled at a distance from the flame front which is sufficient that combustion is complete and temperatures are low enough that sampling equipment operates properly. Two discrete sampling events, including a full suite of field and laboratory parameters, will be conducted for the gas collection system and flare.

Characterization of diffuse gas emission will be accomplished by performing a scan of the entire landfill surface area using organic vapor analysis equipment in the survey (total organics) mode. An initial survey will be conducted using a large sampling point matrix of approximately 100 by 100 feet. The survey will be performed by staking measurement points in the area matrix and walking over the area with the OVA instrument in the survey mode. The survey will be performed by two field project team members. One individual will operate the instrument and the second will record data as the survey proceeds. After review of the survey data, a second survey may be undertaken

using a smaller matrix of points in areas where diffuse gas measurements are highest.

Characterization of gas emissions from landfill drilling sites will be conducted as an integral part of the health and safety monitoring during drilling and leachate well installation activities. In addition to the instruments used for health and safety monitoring, the organic vapor analyzer will be used to monitor borehole gas emissions in the chromatographic mode to further characterize organic gas components. This activity will be supervised by the geotechnical site manager and conducted by the OVA instrument operator.

On-site ambient air monitoring will be conducted during selected meteorological and field activity events to correlate source emissions with ambient air concentrations for selected organic compounds. Data will be collected using the automated meteorological/air quality sampling stations and a self-calibrating portable gas chromatograph linked to the stations or preset for selected conditions. Data will be collected for particular events including (1) "worst case" wind direction and velocity as predicted by the air quality dispersion model used by University of Washington researchers, representative wind velocities in the easterly, southerly, and westerly directions, (3) during on-site leachate well drilling and installation activity, (4) during on-site diffuse gas emission surveys, and (5) during representative flare combustion and flare-out conditions. Project team members and subcontractor staff will maintain the automated monitoring equipment and collect samples as appropriate during the monitoring activity period.

Off-site ambient air monitoring will be conducted in a similar manner to the on-site monitoring activities. A satellite meteorological/air quality station will be set up off-site to the east, south, and west of the landfill in a sequential manner to collect ambient air data for three selected meteorological events. Data will be collected by the automated air sampling systems in a time-weighted manner, and simultaneously at on-site and off-site stations. Equipment will be operated and maintained as indicated above for on-site ambient air monitoring activities.

2.4.4 TASK 4.4 SURFACE WATER MONITORING

Intensive monitoring of surface water will be conducted at sites where stormwater sampling and flow monitoring devices have been installed, and at other surface water sites which may be correlated with the landfill site either through leachate seepage, potential infiltration surfaces or exfiltration conduits such as storm sewers. At least two storm events will be monitored using storm actuated flow and sampling devices installed temporarily at Interstate 5 highway culverts which are connected to pipes that discharge into the landfill. Water quality parameters will be analyzed as described in the revised final RI Sampling Plan.

Water levels at ponds and seeps identified during the field investigation activities will be measured on a daily basis during the intensive monitoring period as determined by the overall work plan schedule. Samples will be obtained as appropriate based on water levels and antecedent conditions and analyzed for the presence of selected indicator pollutants. Hydrologic data associated with surface water run-on will be obtained from on-site climatological instruments as described in Task 4.3. Monitoring well samples and water levels obtained for wet weather conditions will be coordinated with stormwater sampling events to gain insight into overall landfill area water balance.

2.4.5 TASK 4.5 SOILS SAMPLING

Soils samples will be collected at selected off-site seep locations where contaminated leachate is found. The upper two feet of soil will be the collection zone and several soil cores from the contaminated area will be composited to provide one homogeneous sample per site. Soil samples will be extracted in the laboratory and analyzed for parameters of interest based on leachate characterization at the soil sample site. Soil samples will be collected during routine inspections of off-site seeps which are determined to be contaminated.

2.5 TASK 5 DATA ANALYSIS AND REPORT PREPARATION

Gather all data for RPTs now.

The purpose of this task is to analyze and interpret the multi-media data base obtained during the remedial investigation field activities and monitoring program, develop conclusions and recommendations regarding receptor impacts from off-site migration of landfill contaminants, and prepare technical and project reports which summarize the completed work efforts and estimate additional levels of effort necessary to define the nature and extent of particular problem issues. Conclusions and recommendations for further remedial investigation activities will be detailed including plans for further monitoring of installed groundwater/leachate wells, gas probes, ambient air, and surface water. Recommendations will also be provided regarding implementation of a remedial action feasibility study for Midway Landfill. *Objective*

2.5.1 TASK 5.1 DATA ANALYSIS AND INTERPRETATION

The purpose of this task will be to analyze and interpret the data obtained from the field activities. The development of a data management system (described in TASK 6) will allow for the efficient, accurate analysis of generated data. The data analysis will include statistical analysis of each data type in accordance with the procedures outlined in the Midway Landfill Quality Assurance Plan. Statistical correlations of selected data groups will be performed (e.g., correlations between strata permeabilities and gas concentrations) to assist in developing assessments of current conditions and predictions of future conditions. During this task, data action level criteria will be developed which will represent RI/FS decision points for assessing the need for additional data, defining extent and magnitude of contamination, and/or implementing remedial actions.

The output from this task will consist of data summaries, data plots, data statistical correlations, and other items which describe numerically and mathematically the field activities and the monitoring activities completed in accordance with this work plan. Data analysis results will be used to describe as accurately as possible the current conditions within and near the landfill. Locations of all newly placed wells and probes and sampling sites will be recorded on base maps.

Data analysis efforts will include historical long term climatological data assessment, primarily wind direction and velocity and precipitation, and additional ambient air model development and refinement to better define "worst case" atmospheric conditions. Also, groundwater and leachate hydraulics will be described using mathematical relationships and spatial relationships obtained from the remedial investigation data base. *Summary*

2.5.2 TASK 5.2 PROJECT REPORTS

Project reports

A series of technical reports will be generated from the individual field and monitoring activities and data analysis conducted during the RI Project Work Plan implementation. These will be generated as separate documents as work tasks are completed. Information from these individual reports will be utilized in a synoptic manner to conduct further data analysis, plot or draw maps, and reach conclusions regarding remedial investigation objectives. A summary report will be developed at the end of the data analysis and interpretation task which incorporates the individual technical reports as chapters and summarizes the remedial investigation with appropriate verbal or graphic outputs. The summary report to be produced as a result of this task is described below as a separate subtask. A preliminary table of contents for the summary report is attached as Table 5.1.

2.5.2.1 TASK 5.2.1 PROJECT SUMMARY REPORT

An overall summary report will be prepared to present a comprehensive and synoptic review of all RI activities to date. The primary objectives of this report will be (1) synoptic review of all field data, (2) identification of further field data collection needs (3) updated status of off-site surface or subsurface pollutant migration problems including identified receptor populations, and (4) conclusions and recommendations for further remedial action efforts. The report will be organized into major issues discussions using the established data base and individual project technical reports to summarize status of the following issues: gas migration, leachate migration, offsite groundwater contamination, off-site air quality degradation, overall water balance and drainage, and off-site receptor impacts. The project summary report will include an executive summary section suitable for public distribution and fact sheet development. Individual technical reports generated during the remedial investigation will be incorporated into the project summary report as chapters as follows:

o Hydrogeologic Investigation

This chapter will describe the geotechnical and geologic information generated during the installation of the monitoring wells and gas probes. Incorporated into this report will be the results obtained from the soil sampling effort. Standard stratigraphic logs and lithographic descriptions will be included in the chapter. Also included will be geologic cross-sections defining the study area stratigraphy graphically, and plots prepared from the ground survey activities indicating relative locations and elevations. Data from the leachate and groundwater monitoring program will be presented and assessed with respect to rate and direction of movement and quality.

o Gas Migration Investigation

A chapter of the summary report will summarize the results obtained during field and laboratory-generated monitoring of the gas probes. A summary of gas concentrations will be presented. An assessment of the effectiveness of the gas collection system will be made, if sufficient data is available. Spatial and temporal gas relationships will be described, and isopleths of gas concentrations will be prepared on base maps. Statistical regression correlations of data will be completed to establish simple models of migration mechanisms, as appropriate. Additional at-risk areas will be identified, if appropriate.

o Meteorological/Air Quality Investigation

The results of the ambient air/meteorological monitoring will be compiled and presented in an appropriate format. Discussion and plots derived from outputs and predictions of selected air quality model executions will be included. Results will be compared to regulatory limits for those compounds for which ambient air limits exist. Recommendations for additional monitoring, if needed, will be made. Ambient air quality impacts on potential receptors will be assessed with regard to worst case meteorological conditions. Source emissions from the gas control system and diffuse gas emission surveys will be analyzed with respect to system efficiency and ambient air impacts.

o Surface Water Investigation

The data obtained during the surface water investigation will be compiled in a report format. The amount of rainfall and run-on will be summarized, and comparison of the values obtained will be made with previously calculated amounts. The necessity of rerouting surface drainage away from the landfill will be assessed. An overall hydrologic balance will be described based on data obtained to date and closure options for surface water as described in the Midway Landfill Environmental Impact Statement (City of Seattle, August, 1985). Data for ponds and seeps will be summarized with respect to surface and groundwater interactions.

o Receptor Investigation

The receptor populations identified during the course of the field activities will be described. The populations will be described according to paths of contaminant exposure including air, water, and soil. Included in the assessment will be physical resources (residences, businesses, transportation patterns, utility layouts, etc.), wildlife and aquatic resources, and vegetation. The primary method utilized to define potential exposure limits will be geographic overlays of receptor populations and pollutant pathways on study area base maps. These plots will provide sufficient detail to establish geographic limits for additional RI field or monitoring activities.

TABLE 5-1. REMEDIAL INVESTIGATION REPORT FORMAT

EXECUTIVE SUMMARY

1.0 INTRODUCTION

- 1.1 SITE BACKGROUND INFORMATION
- 1.2 NATURE AND EXTENT OF PROBLEM (S)
- 1.3 REMEDIAL INVESTIGATION SUMMARY
- 1.4 OVERVIEW OF REPORT

2.0 SITE FEATURES INVESTIGATION

- 2.1 DEMOGRAPHY
- 2.2 LAND USE
- 2.3 NATURAL RESOURCES
- 2.4 CLIMATOLOGY

3.0 HAZARDOUS SUBSTANCES INVESTIGATION

- 3.1 WASTE TYPES
- 3.2 WASTE COMPONENT CHARACTERISTICS AND BEHAVIOR

4.0 HYDROGEOLOGIC INVESTIGATION

- 4.1 SOILS/GEOLOGY
- 4.2 GROUND WATER

5.0 SURFACE-WATER INVESTIGATION

- 5.1 SURFACE WATER
- 5.2 SEDIMENTS
- 5.3 FLOOD POTENTIAL
- 5.4 DRAINAGE

6.0 AIR INVESTIGATION

- 6.1 CLIMATOLOGICAL PATTERNS
- 6.2 CONTAMINANT QUANTIFICATION

7.0 RECEPTOR INVESTIGATION

- 7.1 POPULATION PATTERNS
- 7.2 FLORA/FAUNA

8.0 PUBLIC HEALTH AND ENVIRONMENTAL CONCERNS

- 8.1 POTENTIAL RECEPTORS
- 8.2 PUBLIC HEALTH IMPACTS
- 8.3 ENVIRONMENTAL IMPACTS

REFERENCES

APPENDICES

2.6 TASK 6 PROJECT MANAGEMENT

Project management will be an ongoing task throughout the proposed work effort. Management activities are expected to include management of staff assignments and budgets, staff or public meetings, preparation of monthly status reports, subcontractor supervision, contract management activities, and data management. Management of the remedial investigation schedule for field activities and monitoring will be a major project management task in this work plan due to the large number of interrelated simultaneous tasks. Staff assignments and organization and subcontract management will also be significant management efforts during work plan implementation.

Data management will be an important project management function for the Midway Landfill remedial investigation effort. A large and diverse data base will be created by field and monitoring activities. Historical and existing data collection efforts have also resulted in a large amount of data which needs to be placed in a manageable format. The following items will be addressed during the implementation of the data management task:

- o Ecology data management format requirements
- o Data types and quantity (historical and projected)
- o Types and volumes of associated data (climatic, geological, water quality, ambient air, gas probe, potable water)
- o QA plan requirements
- o Computer data base and mathematical model format requirements
- o Data security requirements (confidentiality)

The data management system will result in the creation of files that are complete, properly categorized, quality assured, and will include all data attributes (including statistical measures such as mean, median, mode, standard deviation). The data management system files will be accessible to qualified personnel for use in development of contamination assessment (extent and magnitude), the preparation of summary reports, and identification of additional data needs.

data format?

*IBM PC —
AT*

compatible?

— are we ready yet?

2.7 TASK 7 COMMUNITY RELATIONS

Activities identified in the Midway Landfill Community Relations Plan will be implemented during this task. Specific efforts will include preparation of fact sheets for public distribution, a pre-activity public meeting, post-activity public meeting, and condensed summaries of the results obtained during the field investigation.

3.0 PROJECT SCHEDULE

Figure 3.1 describes the proposed remedial investigation schedule. Work plan implementation is expected to begin during January, 1986 and will extend for approximately 32 calendar weeks. Schedule matters will be detailed further during project initiation activities to be conducted during the first two weeks of work plan activity.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 SIXTH AVENUE
SEATTLE, WA 98101

TARGET SHEET

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FIG 3

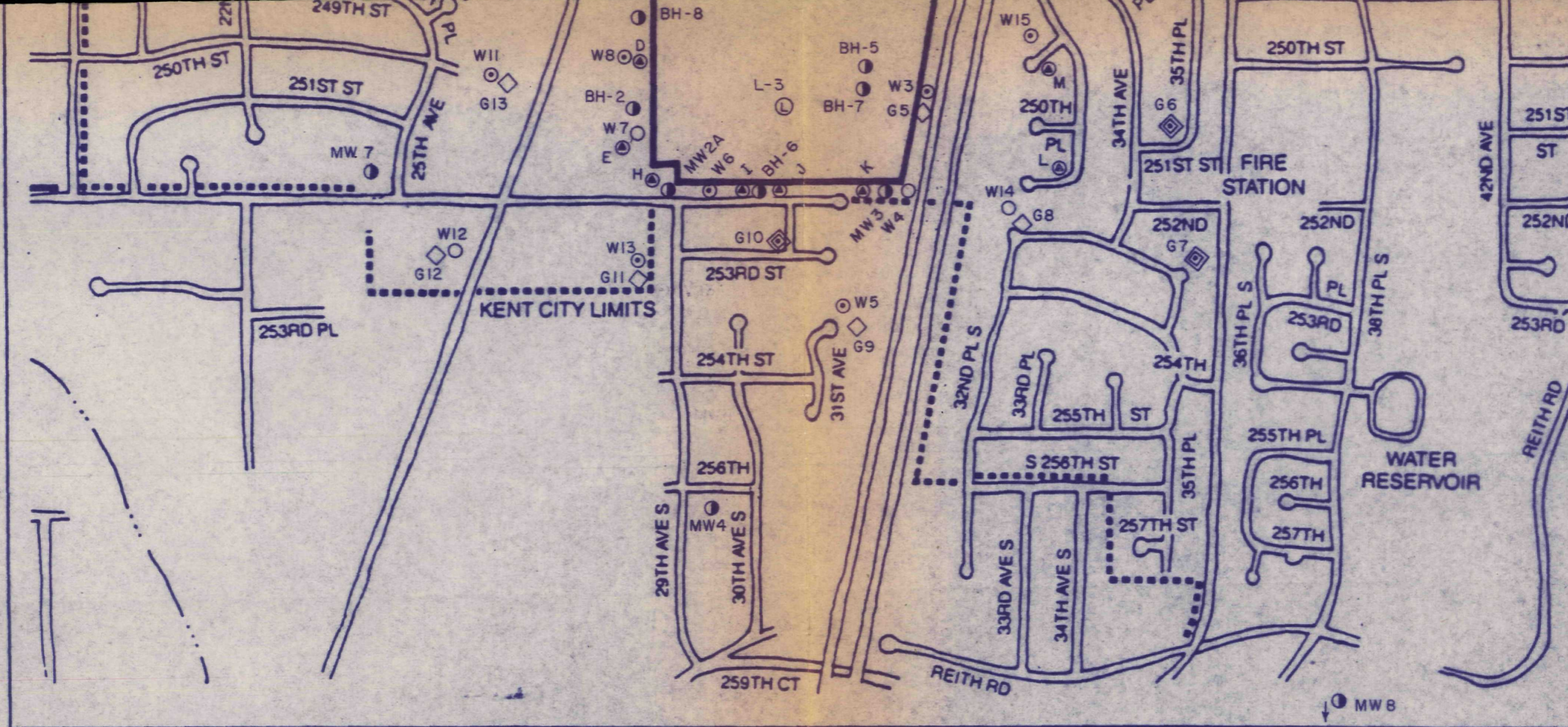
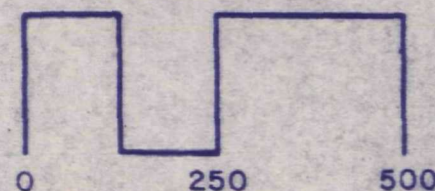


FIGURE 3

LOCATIONS OF MONITORING
WELLS, LEACHATE WELLS,
AND GAS PROBES



SCALE IN FEET

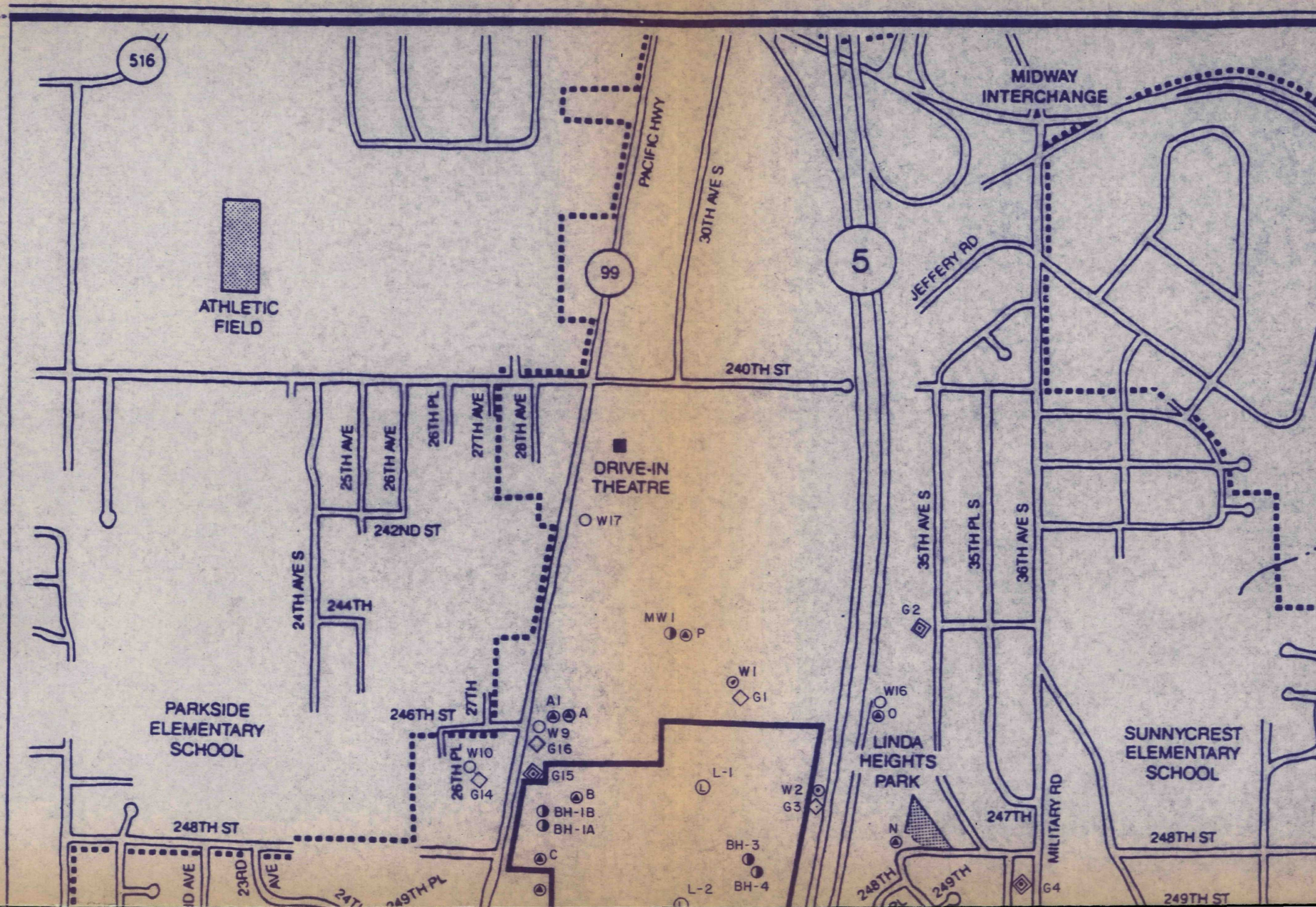


- ⊙ Existing Gas Probes
- ◇ Planned Gas Probes
- ◈ Planned Gas Probe Clusters
- Existing Groundwater Monitoring Wells
- Planned Groundwater Wells
- ⊙ Planned Dual - Completion Groundwater Wells
- Ⓛ Planned Leachate Wells

SUPERFUND BRANCH

NOV 09 1985

RECEIVED



ANDREA BEATTY RINKER
Director



STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

Mail Stop PV-11 • Olympia, Washington 98504-8711 • (206) 459-6000

December 6, 1985

Mr. Louis Romano
Midway Sand and Gravel, Inc.
5049 Lake Washington Boulevard South
Seattle, WA 98118

RECEIVED
DEC 09 1985
SUPERFUND BRANCH

Dear Mr. Romano:

Re: MIDWAY LANDFILL REMEDIAL INVESTIGATION

Enclosed for your review are the Project Workplan for Remedial Investigation Field Activities and the Remedial Investigation Sampling Plan. These documents describe the additional tasks we believe are necessary to adequately characterize the hazards at the site and develop long term solutions for mitigating those hazards.

We are prepared to discuss any questions you may have regarding the workplan. However, in order to avoid unreasonable delays on this project, we have established a January 17, 1986 deadline for completing those discussions. If an agreement cannot be reached by that date, the Department of Ecology and the Environmental Protection Agency will implement the tasks outlined in the workplan, and pursue cost recovery at a later date.

If you have any questions regarding these documents, please contact Mr. David Bradley at (206) 459-6355.

Sincerely,

A handwritten signature in cursive script, appearing to read "John D. Littler".

John D. Littler
Division Supervisor
Remedial Action Division

JDL/cp

cc: Neil Thompson, EPA

ANDREA BEATTY RINKER
Director



STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

Mail Stop PV-11 • Olympia, Washington 98504-8711 • (206) 459-6000

December 6, 1985

Mr. Richard Owings, Director
Solid Waste Utility
Seattle Engineering Department
710 2nd Avenue
Dexter Horton Building, Rm. 750
Seattle, WA 98104

Dear Mr. Owings:

Re: MIDWAY LANDFILL REMEDIAL INVESTIGATION

Enclosed for your review are the Project Workplan for Remedial Investigation Field Activities and the Remedial Investigation Sampling Plan. These documents describe the additional tasks we believe are necessary to adequately characterize the hazards at the site and develop long term solutions for mitigating those hazards.

We are prepared to discuss any questions you may have regarding the workplan. However, in order to avoid unreasonable delays on this project, we have established a January 17, 1986 deadline for completing those discussions. If an agreement cannot be reached by that date, the Department of Ecology and the Environmental Protection Agency will implement the tasks outlined in the workplan, and pursue cost recovery at a later date.

If you have any questions regarding these documents, please contact Mr. David Bradley at (206) 459-6355.

Sincerely,

RECEIVED

DEC 09 1985

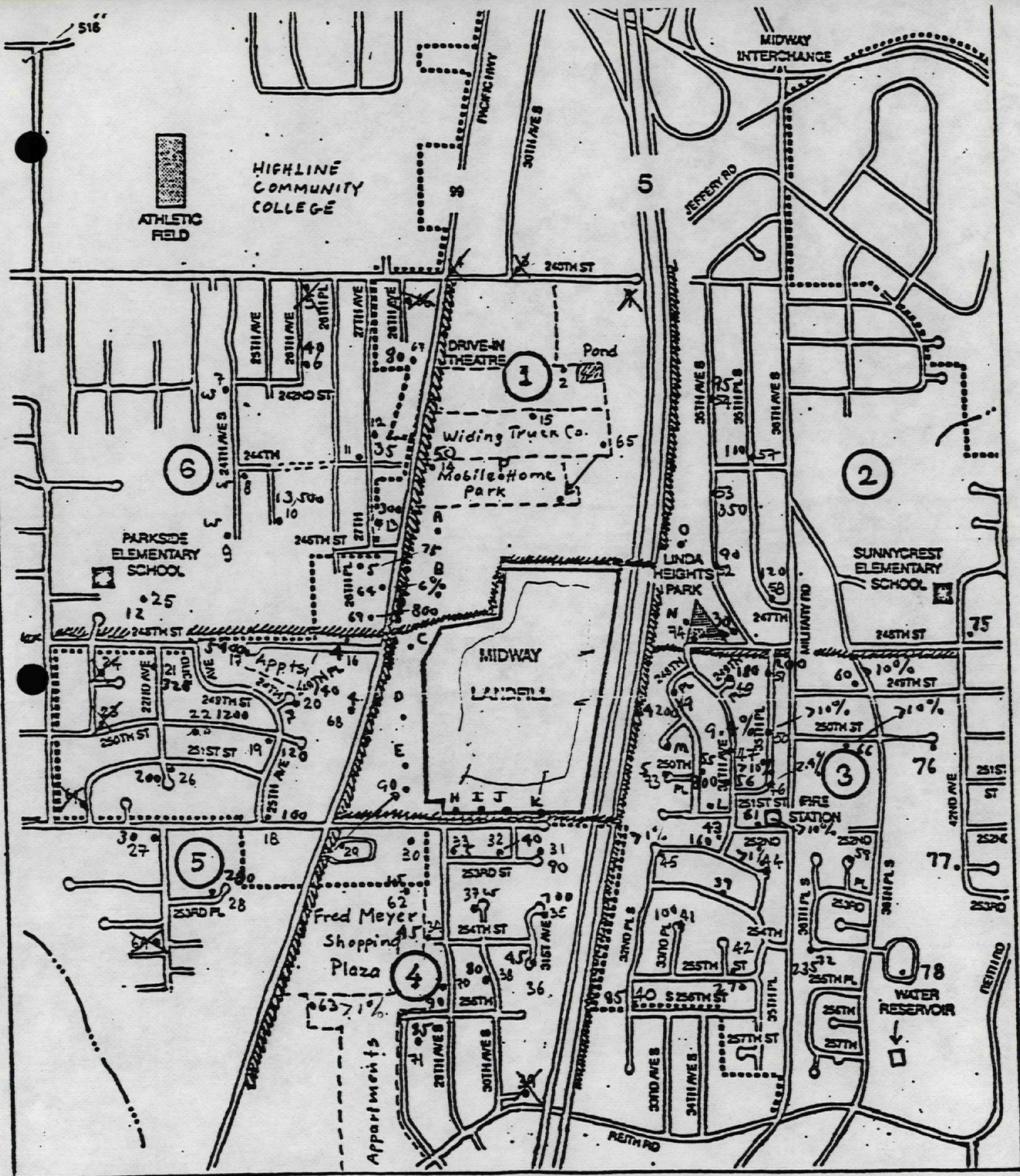
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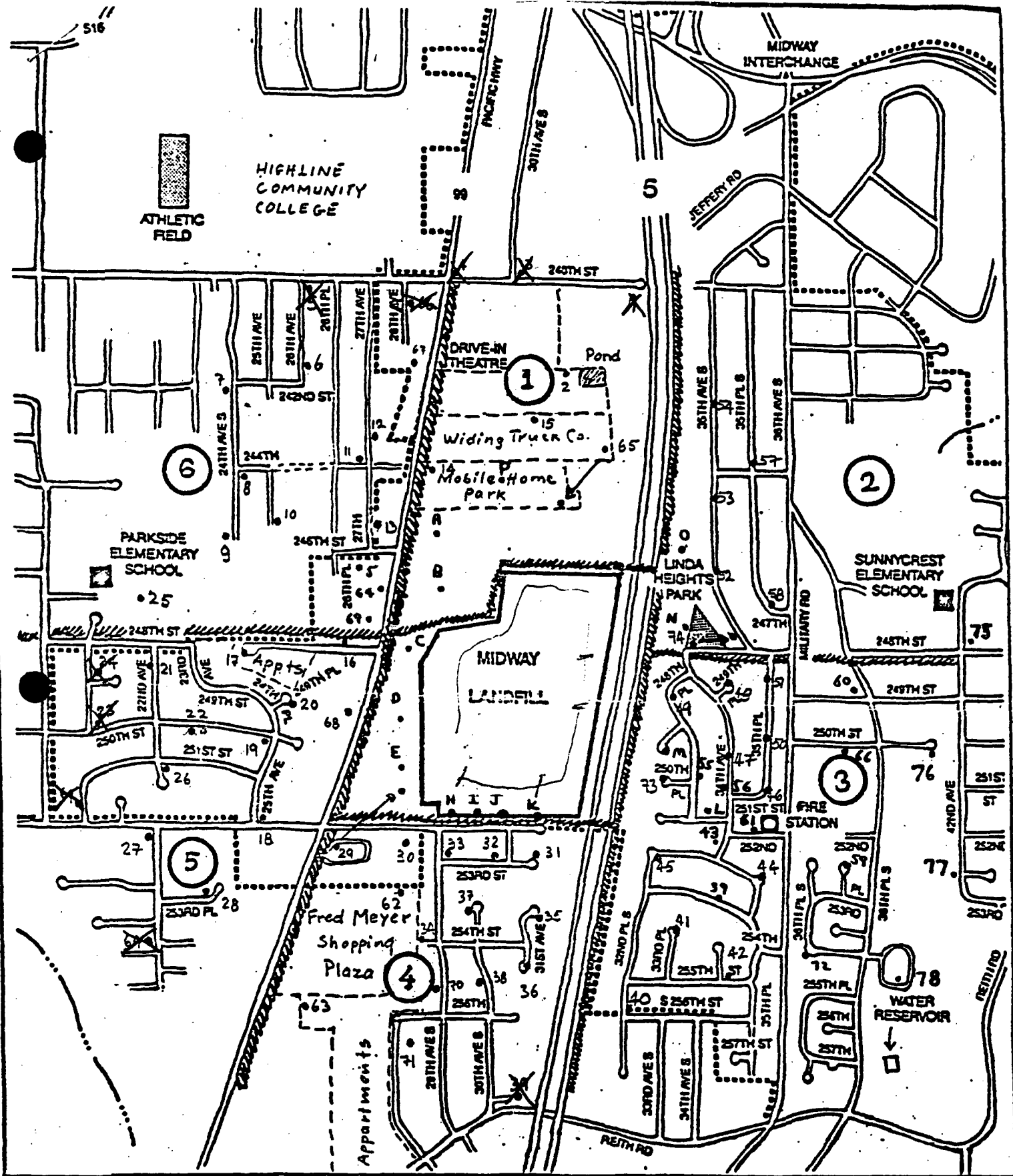
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John D. Littler
Division Supervisor
Remedial Action Division

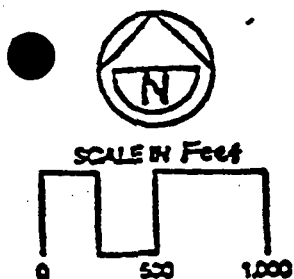
JDL/cp

cc: Neil Thompson, EPA





ATTACHMENT 1



- 1 Proposed drilling locations.
- 1 Location subarea

Midway Gas Probes

<u>East</u>	12/5/85	12/11/85	12/12/85	12/13/85	12/16/85
54					95
57	110				40
58	350			↑	-
52	80			90	20
58	120				90
74					30
75					
49	2200			4200	
48	180				
51	200			90	
60			> 10%		
47	(w)			9.4%	
50	> 1%			> 10%	
66		> 10%	> 10%		
76					
73				5	
55		800			
56		> 10%	> 10%		
46	> 1%			2.4%	
61	3200			> 10%	
43				160	

Midway Gas Probe

East (cont)

	<u>12/5/85</u>	<u>12/11/85</u>	<u>12/13/85</u>
45	1150		> 1%
44	> 1%		1100
59		> 10%	
77			
39			
41	50		100
42	270		80
72		235	
78			
40			85

Midway Gas Probe Readings

South

12/13/85

12/16/85

29

90

82

30

-

33

5

37

40

31

90

62

W

37

W

35

700

34

45

36

45

38

80

70

90

63

> 1%

> 1%

71

85

Midway Gas Probes

North

11/13/85

12/5/85

2

15

14

50

0 (w)

65

Northwest

11/12/85

11/13/85

12/13/85

12/16/85

6

0

6

40

67

4

80

7

200

200

w

12

35

11

8

0

25

w

10

5400

13,500

4000

9

12

w

13

300

300

5

75

64

60000

69

800

25

12

Midway Landfill Gas Probes

West

11/13/85

12/11/85

21

320

17

5400

16

4

20

140

68

4

22

1200

19

120

26

200

18

100

100

27

30

4

28

280

70



STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

Mail Stop PV-11 • Olympia, Washington 98504-8711 • (206) 459-6000

December 17, 1985

Mr. Eugene Avery, Director
Seattle Engineering Department
Room 910 Seattle Municipal Building
Seattle, WA 98104

Dear Mr. Avery:

RE: Midway Landfill Gas Migration Problem

Over the last several months, progress has been made in resolving the gas migration problems at Midway Landfill. An emergency on-site control system is being installed, efforts to define and resolve off-site problems have begun, and regular monitoring of many homes and businesses continues.

Despite these efforts, a great deal remains to be accomplished. Elevated levels of methane continue to be found in homes and businesses and additional evacuations are anticipated. Furthermore, measurements in gas probes installed by Ecology indicate that the gas has migrated much further from the landfill than previously documented. We estimate that over 400 homes and businesses are potentially affected. We believe it is unlikely that the combination of the present on-site system and the localized off-site systems proposed by Seattle Engineering Department will be sufficient to mitigate these hazards.

Therefore, we believe the Seattle Engineering Department has to take a more aggressive approach to resolving these problems. Specifically, the following measures must be undertaken immediately:

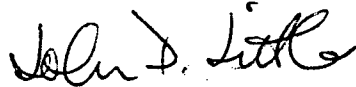
- 1) Given the recent gas monitoring information, it is critically important that several off-site extraction systems be installed. Based on our evaluation of the data, we believe 5-6 extraction wells are needed in the neighborhoods East of I-5. An additional 4-5 wells are needed West of the Landfill.
- 2) Additional efforts are needed to complete the on-site system and fully evaluate its performance.
- 3) Additional house-to-house monitoring will be needed in the neighborhoods East of Military Road. To accomplish this, the Seattle Engineering Department will need to assign additional staff to this project and ensure that they have the necessary equipment.

Although the Solid Waste Utility has attempted to respond to these concerns, it appears that their efforts have been constrained by resource limitations and certain administrative requirements. Given the continuing problems at the site,

we believe your office needs to take additional measures to remove these obstacles and facilitate a more timely resolution of this problem.

Given the emergency nature of this problem, we request that you inform us, no later than Thursday, December 19th, on how you intend to resolve these problems. If you are unable to proceed in a timely manner, Ecology is prepared to undertake this work and recover our costs at a later date. If there are any questions, please contact Mr. David Bradley at (206) 459-6355.

Sincerely,

A handwritten signature in black ink, appearing to read "John D. Littler". The signature is fluid and cursive, with the first name "John" being more prominent.

John D. Littler
Supervisor,
Remedial Action Division

JDL/cp

cc: Mr. Neil Thompson, U.S. EPA